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DISEASE AND THE INDIAN

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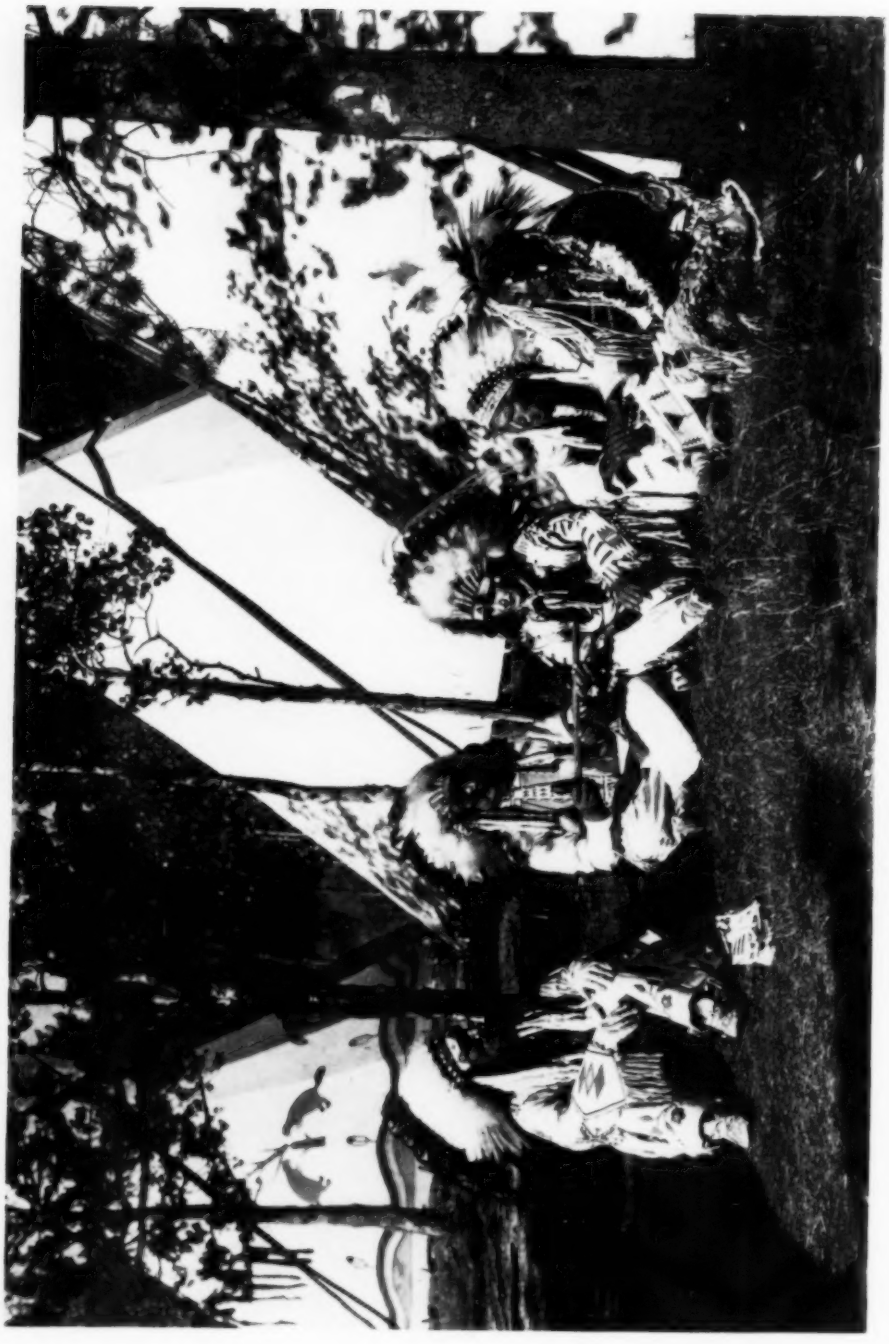
TALKS-WITH-THE-BEAR, the Crow Indian, is ill of an arrow wound. In the group of buffalo hide tepees where his band is gathered for the summer hunt there is no one who has heard of the white man's medicine, for this is in the early nineteenth century, when few white men live in Crow hunting country. The family of Talks-With-The-Bear send for the man who has had a vision giving him arrow wound power. His face painted with streaks of yellow and white, as his vision directed, this "doctor" comes to the door of the sick man's tepee, singing the song he dreamed. He paints the face of the patient and ties an eagle plume to his hair. He bids all the young men help in singing his powerful song, while he dances and strikes the ground with a buffalo tail. Then he and the patient bathe in the river. It was a clean wound and it heals.

Up on the coast of Washington, where the gabled houses of split cedar planks stand ranged along a river, a Quinault Indian lies sick of a wasting disease. His soul is gone, says the medicine man. So the "doctor" must send his own soul out to the land of the dead, a journey of many hours, even days, to find the sick man's soul and bring it back. He chooses a helper and they both lie down on a mat; while the helper shakes a rattle the "doctor" sings and all the bystanders help. It is a song taught to the "doctor" by the spirit which has given him power and it brings the spirit. While the bodies of the "doctor" and his helper lie apparently unconscious following this nervous frenzy, the spirit leads their souls to the land of the dead, where they catch the soul of the dead man—or they do if they are lucky and it has not gone too far. The "doctor" brings back the soul in his cupped hands and pours it into the patient's body through his head.

Farther south, in California, the medicine woman is called to an ailing child. An evil medicine woman, she says, has shot into him a "pain" shaped like a tiny rock crystal. She sucks the foreign object out of his body and even shows it to him. Down in New Mexico, where the stone houses of Zuni cluster among their cornfields, the sick man calls, not upon one medicine man but upon a whole society, for this is a highly organized town, one of the most complex of the ancient Indian world. The curing society sets up an altar in its whitewashed chamber and calls for help on the powerful animals who are so much more at home in the world than man finds himself. Finally they place bear paws on their hands and lay them on the patient, giving him the strength and endurance of the bear.

These are a few of the curing methods practiced by the Indians of North America before the white man came among



INDIANS OF THE BLACKFEET RESERVATION

ADHERING TO THE TRADITIONS AND THE COSTUMES OF THEIR ANCESTORS, NEVERTHELESS HAVE ADVANCED FAR IN THE WAYS OF MODERN PROGRESS DURING THE LAST FEW YEARS. SHOWN HERE ARE SOME OF THE STURDY SURVIVORS OF A GREAT RACE INDULGING IN THE SIGNIFICANT CEREMONIAL OF PASSING THE PEACE PIPE.

them. Various as the practices were, the theory of disease could be reduced to two main principles. Either some foreign object had gotten into the patient's body and must be sucked or charmed out or the patient's soul was gone and must be brought back by the medicine man. They were not such unreasonable theories. That of a foreign object in the body forms to-day an excellent basis for our modern knowledge of germs and that of a soul loss is not unsympathetic to the theories of the psychiatrist. Sorcery in different forms was also thought to produce a number of ailments besides the ones mentioned. So did breach of ceremonial rules, which could sometimes be cured by confession but more often by a new ceremony.

The treatment for any illness which was really serious was generally some version of song prayer and vision. But we can not scoff at their effect, for the patient who knew that his doctor had power from dreams gained thereby a perfect confidence in his own recovery. Modern physicians realize how valuable in connection with any treatment is the patient's conviction that everything is being done. But supplementing the forms of treatment which were chiefly magical, medicine men often used practical therapeutics in the form of massage, sweat baths and herb medicine. Sometimes the "doctor" with his powerful dream acted merely as diagnostician and turned over the actual treatment to some specialist who had learned his method of cure with or without dreaming. In one way or another and in different parts of the country there were Indian doctors who made use of emetics, catharties, haemostatics, massage, bandaging, cauterization and splints. They knew the local herbs, both poisonous and beneficial, and our modern pharmacopoeia contains several drugs of Indian origin, such as cascara sagrada, coco from which cocaine is derived, hydrastis jalap, ipecac and Podophyllum.

The ailments with which these early practitioners had to deal were not the devastating communicable diseases which afflict a civilized population. The Indian population in hunting and food-gathering areas was about one person to the square mile. In such country the food-gathering peoples of California erected their temporary dwellings of brush and mud, usually destroyed after a death. The Algonquins of our Northeast set up their bark wigwams or the Sioux their tepees of buffalo hide. All these were frequently renewed and therefore free from accumulated filth of modern cities. Their inhabitants rarely collected in large groups and when they did the gathering was a temporary one, for hunting or ceremonies. Even had an epidemic begun among them, it could not spread far.

In agricultural communities larger numbers of persons lived together, but rarely in groups of more than two or three hundred. The Iroquois of New York State had their stockaded villages, where the long houses of elm bark might accommodate six or eight families, housed in two rows, as in the compartments of a sleeping car. The Mandan lived in domed earth-covered dwellings, warm in winter and cool in summer. The people of the Pueblos, the most highly civilized of all, had square-built rooms of stone or adobe, piled on one another like a modern apartment house. Here was some approach to the white man's conditions, but the saving grace was that even the village Indians were outdoor people. Their business was agriculture and the men—or often the women—were in the fields from morning to night. Those who worked at crafts, such as pottery, skin dressing, basketry, arrow-making, were usually out of doors in the sunshine. Their clothing was scanty. California men wore nothing, Pueblo men only a breechclout; women usually had arms and legs bare. Even the Indians of colder climates had their skins exposed

to the sun rays in warm weather, as do the health seekers on beaches to-day. Their food, according to the locality where they lived, was meat, fish, vegetables (often eaten raw), nuts, seeds and fruits. Few areas had all these possibilities but, since Indians ate every part of an animal and every edible plant in their locality, they came nearer a balanced ration than might be supposed.

Sometimes they did suffer from malnutrition on errors of diet and sometimes their arduous life exposed them to pneumonia, arthritis or injuries through accidents. Indeed the preponderance of female skeletons in Indian burial places would indicate that the majority of males were killed in battle or while out on the hunt. But on the whole, says Dr. Hrdlička of the Smithsonian Institution, America, before its discovery by Columbus, was one of the most healthful of continents, if not the most so.[1] His studies have shown that skeletal remains of that time are, barring a few exceptions, remarkably free from disease. Apparently there was no rachitis, no proved tuberculosis, no smallpox, measles or trachoma; cancer was rare, and even fractures infrequent. Furthermore, there is as yet not a single instance of thoroughly authenticated pre-Columbian syphilis. Even in the childhood of Indians now living, these white man's diseases were rare in the remoter localities. I have been informed in personal conversation with some older Indians that in their early youth they knew nothing of either trachoma or tuberculosis.

All this was changed when the white settlers swept across America, bringing diseases old in Europe but new and deadly to the Indians. Even before the Pilgrim Fathers landed on Plymouth Rock, smallpox had been brought to New England by coasting vessels or perhaps by the French to the north. One reason the Puritans were allowed to settle so peacefully was that the near-by Indian village had been abandoned because of the epidemic. Back through the forest country the epidemic had made its way until the deserted Indian village sites seemed, said an early trader, "like a new Golgotha," littered with bones and skulls.

Against a cataclysm like this the prayers and the consolation of the medicine man were completely unavailing. The susceptible, unvaccinated Indians died off until the Massachusetts tribe was reduced from 3,000 to 1,000. As far south as the Delaware River villages were abandoned, never to be revived.

As the pioneers moved west the disease moved ahead of them. We learn from Schoolcraft[2] of conditions which read like pages from John Evelyn or Boccaccio of the bubonic plague in Europe. According to the records, smallpox swept through the Missouri Valley in 1837. An employee on a Missouri River steamboat was the initial focus. From him it became epidemic at a trading post about 500 miles above St. Louis. Precautions were taken by sending Indian runners to the Indian camps two days ahead of the boat but to no avail. The Mandans, a tribe consisting of 1,600 persons, were reduced to 31. The Minnetarees, living in that vicinity, were next attacked and of 1,000 of this tribe, 500 remained. Of 3,000 Arickarees, only 1,500 survived. Then it spread to the Assiniboins, Crows and Blackfeet. To quote one paragraph from this account:

> Granting everything that can be asked on the score of excitement and exaggeration, not less than 10,000 persons fell before this destroying disease in a few weeks. An eye-witness of this scene, writing from Fort Union on the 27th of November, 1837, says: "Language, however forcible, can convey but a faint idea of the scene of desolation which the country now presents. In whatever direction you turn, nothing but sad wrecks of mortality meet the eye. Lodges standing on every hill, but not a streak of smoke rising from them. Not a sound can be heard to

[1] *Journal of the American Medical Association*, November 12, 1932.

[2] "History, Condition and Prospects of the Indian Tribes of the United States," Vol. I., 1853.

THE NEW INDIAN GENERAL HOSPITAL AT FORT DEFIANCE, ARIZONA

break the awful stillness save the ominous croak of ravens and the mournful howl of wolves, fattening on the human carcasses that lie strewed around. It seems as if the very genius of desolation had stalked through the prairies and wreaked his vengeance on everything bearing the shape of humanity."

As allies of smallpox to further smite these people were tuberculosis, venereal diseases and trachoma, which will be discussed severally in this narrative.

As early as 1824 the Bureau of Indian Affairs was organized in the War Department, as the Government apparently recognized the multitudinous problems occasioned by the wardship of another race. When the Department of the Interior was created by the Act of 1849, the Bureau (now called Office) of Indian Affairs was made a part of this new department and the administration of the Indian Office passed from military to civil control. It was not until 1924 that there was actually organized in the Office of Indian Affairs a division of health. Two years later, cooperative relationships were consummated with the Public Health Service, whereby the Director of Health for the Indian Service was selected from that corps, as well as a limited number of field supervisors. The medical organization of the Indian Office in brief consists of the director of health, an assistant director, a hospital administrator, a pharmacist, a part-time supervisory dental surgeon and a director of nursing. These are in Washington. In the field there are found medical directors acting as advisers in certain areas, special physicians in tuberculosis and trachoma, general physicians, dentists and nurses in hospitals and engaged in public health, also a certain number of supervisory field nurses at large. Indian women entered the field of professional nursing as early as 1890. Many practiced among the white population exclusively, others returned to their community or entered the Indian Service. At the present time about 15 per cent. of our total nursing force is Indian, either in part or full blood. The two racial characteristics that are predomi-

nant and useful in this occupation are their manual dexterity and their imperturbability.

A school for nurse aids has been established at the Kiowa Hospital in Lawton, Oklahoma. It is found useful to give training to young women as subsidiary hospital personnel. They are employed, after nine months of supervised experience and training, in the wards of the hospital as aids to the professional nurses. This training and experience does not qualify them to exercise professional judgment nor to take full responsibility for the care of patients, but it materially increases their skill and understanding of hospital work and the care of sickness. They give baths, take temperatures, helping in many ways to extend routine nursing care, thus conserving the time of the professional nurse for duties demanding her greater skill. This school has been operating for two years and we find that it has been practically useful in furnishing a better type of hospital personnel; also it has been an incentive to Indian young women to go into the professional field of nursing. Most of the selections are made from high-school graduates so that they can go further if they so desire. The total field force is approximately 1,700 employees. The patients of this medical group represent a people numbering about 350,000 belonging to 230 tribes and scattered throughout the Union in 26 States on 200 reservations.

These potential patients of the Government do not now represent a distinct ethnic group which has maintained its original racial characteristics and customs. In many sections there has been a blending of races and a modification of customs. However, in certain sections of the Southwest and Florida the Indians live very much as when found by the early Spanish settlers, while in many parts of Oklahoma they and the whites live on adjoining properties and participate equally in political and social affairs.

Tuberculosis is the great Indian killer. A perusal of the literature regarding the extent of tuberculosis infection among Indians in the years gone by reveals much that has been written, but comparatively little which can be used as a definite basis for comparison as to what the morbidity rate was years ago and what is found at the present day. As early as 1633, references are recorded of the observations of the Jesuit Fathers. In that year, speaking of scrofula, one observer says, "They are nearly all attacked by this disease when they are young." This reference to scrofula among Indians is predominant for the next hundred years. On the other hand, we find a reference in 1794 by Dr. Benjamin Rush to the effect that "It (pulmonary consumption) is unknown among Indians of North America" (a statement which has been challenged).[3] Lewis and Clarke in a report of their travels from 1804 to 1806 state that the Indians are "generally healthy, the only disorders which we have had occasion to remark being of a scrofulous kind." J. G. Hunter, in an article appearing in the *American Medical Record*, Philadelphia, 1823, says in part, "I have known pulmonary consumption to occur among the Indians. It is rarely seen, however, except in those who are addicted to intemperance, and even in these it is by no means so common as among the whites." Dr. Matthews, of the United States Army, who has written much on early tuberculosis among the Indians, reports that in 1865 among the Indians of Dakota and Montana consumption was but little known. These same Indians were observed 22 years later by a Dr. Treon, who stated that "The first diseases to which my attention was directed when I reached the Agency were consumption and scrofula."

These speculations as to the origin of tuberculosis among Indians of the North

[3] Stephen Maher, *American Review of Tuberculosis*, 1929.

INDIAN TUBERCULOSIS SANATORIUM AT SHAWNEE, OKLAHOMA

American continent are interesting as conjecture and speculation, but it is as difficult to explain satisfactorily as is the origin of any other disease. We can summarize the literature by the statement that tuberculosis did exist to some degree in the Indians while they were living in their natural state in post-Columbian times, and that the spread of this disease was greatly enhanced when they were forced on reservations, living in closer proximity with one another and with the whites, and under domestic environments which were quite different from those to which their ancestors had been accustomed. This, together with the fact that they had not made peace with the tubercle bacilli through years of hereditary immunity, has caused this disease to spread rapidly among them and with devastating results.

Attempts have been made to determine the tuberculosis rate through general clinical surveys. In a series of group surveys from 1927 to 1932, there is record of 17,169 Indians examined, all ages, with 1,730 positive cases reported. This would give an incidence of 10 per cent., with the childhood type of tuberculosis included. We do know that the mortality rate is high and on this point there are definite figures. More Indians die from the disease in the North and Northwestern States than in the South and Southwestern areas. In 1935 there was an estimated Indian population of 106,420 in the States of Idaho, Iowa, Minnesota, Montana, Nebraska, North Dakota and Oregon. Among this group in one year the reported death rate from tuberculosis was 213.3 per 100,000. In that same year there were reported 119,223 Indians in the States of Arizona, California, Colorado, Kansas, Mississippi, Nevada, New Mexico, North Carolina, Oklahoma and Utah. Among this group the death rate was 204.7 per 100,000. It is known that the death rate from tuberculosis among Indians is from three to four times greater than among the whites, dependent on locality. It is as yet extremely rare to find tuberculosis among the Seminole group living in the Florida Everglades.

A very interesting survey was accomplished by the Cattaraugus County Department of Health, New York State, in cooperation with the Indian Service, on the Alleghany Indian Reservation in 1935. Six hundred and fifty Indians

were examined in a population group of 972. In a personal communication to the writer, Dr. Korns, at that time director of the Bureau of Tuberculosis (who, with Atwater, conducted the survey), had this to say: "The County Department of Health was relieved of the suspicion that there might be numerous foci of tuberculosis spreaders in the reservation; the findings do not warrant that suspicion. The x-ray films showed considerable ability to build up fibrous tissue and this is encouraging to health work. These Indians do not seem to constitute 'virgin soil' for tuberculosis infection any more. I was impressed with the sturdy rather robust nature of most of the adults. They have fewer postural defects than the white persons I see in clinics."

In that same year, Long, of the Phipps Institute and tuberculosis consultant for the Indian Office, conducted a similar survey in cooperation with the Indian Service on the Papago reservation in Arizona. In this survey 530 Indians were examined. In the published report[4] is this statement: "Taking into account the character and extent of lesion as well as the scarcity of significant progressive disease of the childhood type, we feel that pulmonary tuberculosis among the Indians studied conforms more closely to the type of pulmonary tuberculosis seen in white patients at the Henry Phipps Institute than to the massive and rapidly progressive type more often seen in negro patients."

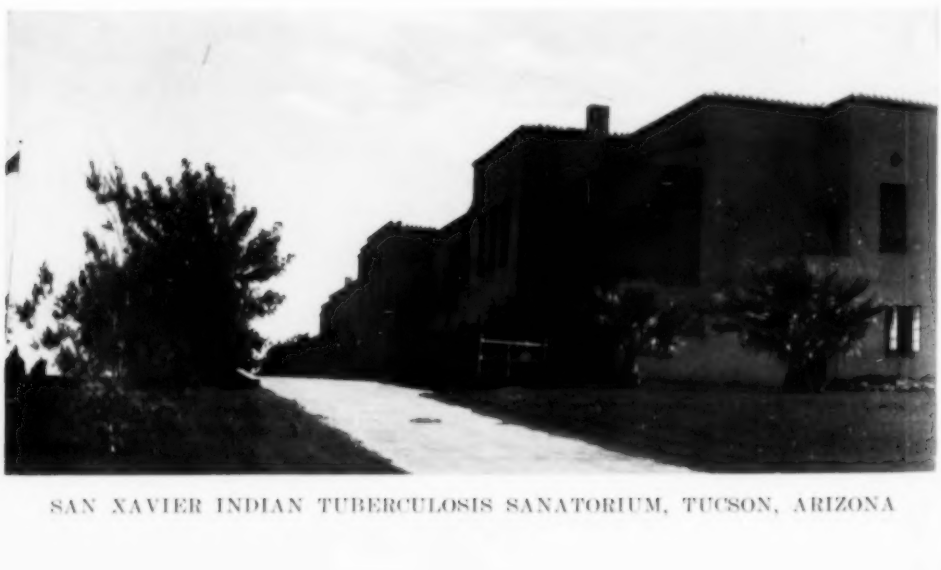
These two independent observations in different sections of the country are encouraging in that there is reason for belief that the Indian race is gradually building up a resistance against tuberculous infection.

The State Board of Health of Montana has made interesting studies on the reservations in that state which show definitely that there was a higher incidence of tuberculosis among the full-blood Indians examined and that this index progressively dropped in proportion to the white admixture of blood. The same is also true of the mortality rates.[5]

The Indian Service is striving to meet the problem through education and hos-

[4] "A Tuberculosis Survey in the Papago Indian Area of Southern Arizona," Esmond R. Long and H. W. Hetherington, *Supplement to The American Review of Tuberculosis*, March, 1936.

[5] "A Study of Tuberculosis Among the Indians in Montana," by J. H. Crouch, M.D., C.P.H., Montana State Board of Health, Public Health Reports, U. S. Public Health Service, Sept. 16, 1932.



SAN XAVIER INDIAN TUBERCULOSIS SANATORIUM, TUCSON, ARIZONA

TRACHOMA TREATMENTS AT THE CHEMAWA INDIAN SCHOOL, OREGON

pitalization. There are 81 general hospitals and 14 tuberculosis sanatoria. The total number of beds in the tuberculosis sanatoria is 1,421. Besides, approximately 1,700 tuberculosis patients are treated in general hospitals, a number of the newer ones having tuberculosis wards.

Educational activities through the medium of the field nurse and field physician are responsible often for bringing about hospitalization, while an educational program during the time the patient is taking treatment is utilized. Pneumothorax is a type of treatment to which the Indian responds and is becoming more widely spread as the Indian Service physician is trained in this technique. Special physicians who have been trained at the Phipps Institute are conducting surveys with the assistance of specially trained tuberculosis nurses in an effort to find a true picture of tuberculosis incidence and the classification of cases. Those who can be given pneumothorax injections are so treated; others who need hospitalization are provided for and the school authorities and parents advised of the childhood type of the disease when found for special consideration of that individual child. It will be some time yet before the Indian race approaches the lower morbidity as found among his white brothers, for the whole problem is so interwoven and entangled with economics and poverty that many other lines of approach will have to be encouraged and consummated before our ultimate goal in the control of tuberculosis among the Indian race is really reached.

Of 5,342 pupils, average age 13 years, representing various tribes in 30 different localities in the Southwest, 74.1 per cent. showed a positive tuberculin test. In four non-reservation boarding schools, Santa Fe, Albuquerque, Fort Wingate and Phoenix, in which are found the older groups of pupils, the average age being 17 years, the positive rate averaged 90.6 per cent., this in 1,700 pupils. In the reservation schools, where the average age was approximately 11 years, the positive rate was 65.6 per cent.

When the Indians first developed trachomatous eyes is unknown. It is not

A TRACHOMA CLINIC

remembered by the older ones as being prevalent, although old records do call attention to "bad eyes," conjunctivitis, scrofulous eyes and terms of that nature. The theory has been advanced that Coronado at the time of the invasion of Arizona and New Mexico in the early sixteenth century might have been the cause of its introduction, but this is purely conjecture. However, we do know that it is much too prevalent among this racial group on the North American continent —unusually high when consideration is given to the general rate among the white race in the United States.

The first systematic survey to determine the prevalence of this condition was accomplished in 1912, when the Public Health Service[6] undertook a complete survey of the Indian population. All states were visited where Indians reside, and a total of 39,231 Indians were seen. Of this number, 8,940, or 22.7 per cent. of the entire number, were found to be infected. This included both sexes in all ages. The degree of infectivity varied in this record according to locality from as high as 68.7 per cent. in Oklahoma to none in Florida. It is unquestionably true that the rate has been materially reduced since that time. Among 17,320 examined in group surveys, all ages, on 24 reservations, between 1927 and 1931, 1,213 positive cases were found, or 8 per cent. The disease does vary remarkably according to tribe. The highest infection group now is the Navajos, in Arizona, where approximately 30 per cent. are infected, whereas among the Florida Seminoles there has never been a case reported, nor is trachoma found among the Taholah group at Neah Bay in the northwest tip of Washington State. Quoting from a report prepared by Mountin and Townsend[7] while on a survey in 1934: "Miscellaneous groups in Wisconsin, those at Cherokee, North Carolina, and at Cloquet, Minnesota, show practically no trachoma. In Oklahoma probably less than 5 per cent. have the disease. Among the Mission Indians of Southern California, it runs about 3 or 4 per cent. In the Northwest there is little trachoma west of the Cascade Mountains, but among the Flathead,

[6] "Contagious and Infectious Diseases among the Indians," Senate Document No. 1038, 62d Congress, 3d Session.

[7] "Observations on Indian Health Problems and Facilities," by Surgeon J. W. Mountin and Senior Surgeon J. G. Townsend, U. S. Public Health Service Bulletin No. 223, Feb., 1936.

Blackfeet and other Montana tribes, 20 per cent. or more of the Indians show evidence of the disease. In the Dakotas about 5 per cent. of the Sioux have trachoma. The Chippewas in Minnesota have less. In the Southwest the same differences are to be found among the several tribes. For example, at Zuni fewer than one per cent. of the Indians have trachoma, while in the pueblos about Laguna the incidence runs from 16 to 25 per cent. About 30 per cent. of the Navajos show evidences of trachoma and the same is true of the Apaches at San Carlos and Fort Apache; but, curiously enough, a recent survey of the Apaches at Jicarilla revealed only one per cent. of the Indians to be afflicted with the disease."

This peculiar incidence, especially when a high infectivity rate is noticed in one tribe contiguous to another tribe where the rate is almost nil, and yet social intercourse and free intermingling prevail, is a matter that warrants further study and research.

The trachoma activities in the Indian Service are organized under a medical director in charge and a corps of special physicians trained in the work, who visit reservations and schools for the purpose of rendering treatments. They are accompanied by specially trained nurses. These physicians also act as consultants to the local physicians at the various field stations.

There is maintained a special trachoma school on the Fort Apache, Arizona, reservation, and at this place, in cooperation with Columbia University, research studies for the past few years have been carried out on the etiology of this disease. By the concentration of trachomatous children here for the past three years trachoma has been practically eradicated from the school group on this reservation. Much yet has to be done in education and intensive treatments, especially among the adults.

Next to tuberculosis, the great enemy of the Indian is the high infant mortality rate. The last available report shows an Indian infant death rate per thousand live births one year of age and under of 97, whereas the rate in the registration area is 56.9. This condition is due primarily to dietary disorders and contagious diseases of childhood, predominantly measles and enteric infections. With this high infant death rate, however, there is an encouraging note in the fact that the general birth rate is 23.8 per thousand and the general death rate 16.4 per thousand, which gives the Indian a favorable balance and insures his perpetuity.

Studies have been carried on in New Mexico for several years on diarrhoeal disorders among Indian, Spanish and white groups. This was made possible through the cooperation of the Public Health Service, the Indian Service and the DeLamar Institute of Public Health, Columbia University. Among the Indian groups a high percentage were found to harbor the amoeba hystolitica, the cause of amoebic dysentery, and also the bacilli of Shiga and the bacilli of Flexner, causing infectious diarrhoeas. For example, in a group of 382 Indians examined in seven localities in New Mexico, 40.2 to 18 per cent. harbored the amoeba in the intestinal tract. These studies are being pursued and experimental areas selected for preventive measures by the use of sanitary privies. In one area in a population of 1,000 and with 28 cases of acute diarrhoea reported, of which 14 had infectious dysentery, and with a total of 250 of the general population examined with 7.2 per cent. yielding specific organisms, the following year after the installation of these sanitary precautions there was only one case of diarrhoea reported and that was mild. It is trusted that these studies will lead to further effort elsewhere.

The venereal diseases are difficult to

INDIAN CHILDREN IN THE TUBERCULOSIS SANATORIUM ON THE JICARILLA-APACHE RESERVATION, NEW MEXICO

ONE OF THE SPECIAL INDIAN SCHOOLS WHERE TRACHOMATOUS CHILDREN ARE SENT FOR TREATMENT. A GROUP OF YOUNG PATIENTS AT THE CHEMAWA INDIAN SCHOOL

measure accurately. As would be expected, the higher incidence is near the population centers, the less incidence in the far-away places. From Wassermann surveys done indiscriminately at the time of examinations, the incidence, including all degrees of plus reactions, is about 8 per cent.—higher than the white but lower than the Negro race. Of scientific interest is the observation that syphilis does not do appreciable damage to the central nervous system of the Indian. General paresis, locomotor ataxia and gummata are rare. Nor does syphilis seem to measurably affect the cardiovascular system of the Indian. This observation is worthy of further study.

Venereal diseases are being treated routinely when found and for this purpose the out-patient clinics are utilized. A large clinic is now in operation at Anadarko, Oklahoma, as an example, and among the Osage tribe at Pawhuska, Oklahoma, is a modern clinic for diagnostic purposes which is supported entirely from tribal funds. This health clinic is the result of the voluntary desire of the Osages to have this service and they could afford to pay for it. Emphasis is placed elsewhere on the routine Wassermann examinations of all patients entering hospitals and of expectant mothers.

Malignancy among the Indian race has intrigued investigators for some time. In 1921 Hoffman, consulting statistician of The Prudential Insurance Company of America,[8] made an exhaustive compilation of what figures were available as to Indian cancer mortality. He reported during the five-year period 1921–1925 that 2.34 per cent. of Indian deaths in the registration area were due to this cause, in comparison with an 8 per cent. cancer death rate in the total registration area, all races. These figures were not based on population as figures at that time were not reliable, but Hoffman indicates that this would indicate an average frequency of 55 per 100,000. In 1925, for the whole registration area, the rate was 92.6 per 100,000. It was higher in females and was more common in the involvement of the stomach and liver, 45.6 per cent. in Indians as compared to 37.6 per cent. in whites. Among Indian females the generative organs were involved in 19.9 per cent. of cases, as compared to 14.1 per cent. in whites, but breast cancers were more common in whites, with a ratio of 9.1 per cent. compared to 4.7 per cent. among the Indians.

Then in 1936 Dr. E. Payne Palmer,[9] of Phoenix, Arizona, made a similar study. He based his rates on population studies and noticed an increased rate in both races, white and Indian, in 1928–1933. In 1933 the white rate was 97.6 per 100,000 and the Indian 42. He confirms Hoffman's report of a high incidence of stomach cancer among Indians and whites, but includes in this the duodenum (54.9 per 100,000 for Indians, 281 for whites). In these studies the involvement of the female generative organs was higher among whites than Indians. There is also confirmation that there is a higher incidence of breast cancer among whites than among Indians, being 59.4 per 100,000 among whites as against 12.3 per 100,000 in Indians.

The Health Division of the Indian Service has reviewed this paucity of cancer cases among the Indian race in comparison with the white and there are possibly two factors which should be considered:

(1) Before any intensive medical care or public health work was carried out among Indians their expectancy of life was not as long as that of the whites and therefore many did not reach the cancer age.

[8] "Cancer among North American Indians," Frederick L. Hoffman, LL.D., The Prudential Insurance Company of America, Newark, N. J.

[9] "The Incidence of Cancer among the Indians of the United States and Canada," E. Payne Palmer, M.D., F.A.C., Phoenix, Arizona.

(2) The failure to diagnose incipient cases.

A more intensive hospitalization program now in vogue and the development of post-mortems and tissue examination may change the picture somewhat, but even so, this disparity of rates should stimulate more intensive study and research in this phase of Indian health.

Dr. Paul, from the Department of Medicine, Yale University,[10] completed a study in 1936 on the prevalence of rheumatic heart disease among Indian school children. He found that among the northern tribes between the Canadian line and the southern border of Wyoming the rate in 6,088 children was 45 per thousand. In the middle zone, extending to the middle of New Mexico and Arizona, in a group of 1,106 children the rate was 19 per thousand, while in the southern zone, extending to the Mexican line, in a group of 1,019 children the rate was only five per thousand. This study was undertaken to determine the effects of climate upon this disease.

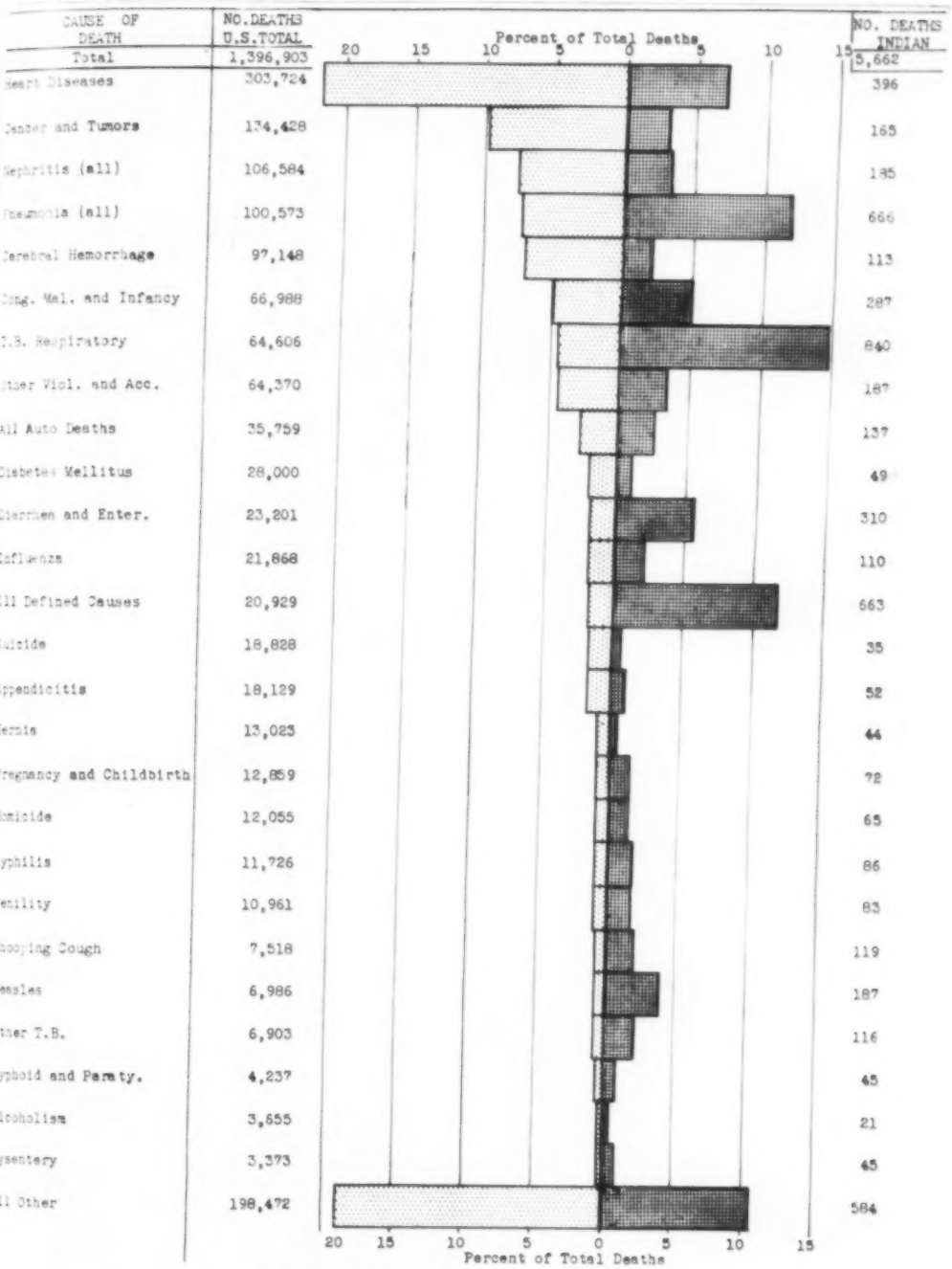
In addition to conditions described, the Indians as a race bear with the general run of human ills in about the same proportion as the whites. Influenza has its seasonal march, being responsible for 34.6 per cent. of the 40,980 contagious and infectious diseases reported in the fiscal year 1937, with impetigo 16.4 per cent. The smallpox incidence was 0.1 per cent., typhoid and paratyphoid .3 per cent.; and diphtheria 0.2 per cent. These rates are average. These latter three plagues are controlled by biological immunization and find a more ready acceptance among Indians than in certain white groups. The white race can learn much from the Indian in practical smallpox control.

The bar graph of deaths by selected causes in the Indian race and in the total registration area shows a relativity of mortality incidence which is true to-day. The Indian race is handicapped with certain conditions described but does not suffer in the same proportion as the white race from cardio-vascular changes, malignancies, nephritis, and should have more security from the accidental deaths so commonly seen in large cities and in thickly populated centers.

During the last four years there has been a renaissance in modern hospital construction in the Indian Service, due to special appropriations and special governmental grants. The Indians in increasing number are utilizing these facilities. This may be exemplified in the obstetrical services. In 1930, of 4,118 live births reported, 26.6 per cent. of babies were delivered in Indian hospitals. In 1937, of 5,654 live births reported, 59.6 per cent. were hospital deliveries, and the years have shown a steady increase even before 1930.

Dentistry is practiced among Indian groups on a limited scale, there being only 14 dentists on a traveling status and a few full-time and contract dentists operating in hospital units. The itinerant dentists cover contiguous states, visiting various reservations and school centers. Of necessity the emphasis is placed on the treatment of the child, although adults are treated in emergencies and to relieve pain. The dental caries rate among tribes varies according to locality and seems to be in ratio to certain dietary habits. The condition is not so common among meat eaters. Among the Navajos, where there is a low incidence of dental caries, their main subsistence is milk and mutton. The Apaches have a low incidence, subsisting largely on beef, and the same may be said of the Pima tribe in Arizona. Among the Pueblo groups in New Mexico, however, we find at least three times as much caries as among the Navajos. These people eat starchy foods, sweets,

[10] "Climate and Rheumatic Heart Disease," John R. Paul, M.D., and Geo. L. Dixon, M.D., *Journal of the American Medical Association*, June 19, 1937, Vol. 108, pp. 2096–2100.


CAUSE OF DEATH
NO. DEATHS U.S. TOTAL
NO. DEATHS INDIAN
Percent of Total Deaths
20 15 10 5 0 5 10 15
Total 1,396,903 5,662
Heart Diseases 303,724 396
Cancer and Tumors 134,428 165
Nephritis (all) 106,584 185
Pneumonia (all) 100,573 666
Cerebral Hemorrhage 97,148 113
Cong. Mal. and Infancy 66,988 287
T.B. Respiratory 64,606 840
Other Viol. and Acc. 64,370 187
All Auto Deaths 35,759 137
Diabetes Mellitus 28,000 49
Diarrhea and Enter. 23,201 310
Influenza 21,868 110
Ill Defined Causes 20,929 663
Suicide 18,828 35
Appendicitis 18,129 52
Hernia 13,023 44
Pregnancy and Childbirth 12,859 72
Homicide 12,055 65
Syphilis 11,726 86
Senility 10,961 83
Whooping Cough 7,518 119
Measles 6,986 187
Other T.B. 6,903 116
Typhoid and Paraty. 4,237 45
Alcoholism 3,655 21
Dysentery 3,373 45
All Other 198,472 584
20 15 10 5 0 5 10 15
Percent of Total Deaths

DEATHS BY SELECTED CAUSES—1934

THIS GRAPH PRESENTS TRENDS WHICH HAVE NOT CHANGED. IN THE TOTAL NUMBER OF DEATHS REPORTED, ALL AGES, IS THE HIGHER MORTALITY FROM CARDIO-VASCULAR DISEASE, CANCER AND NEPHRITIS; AMONG INDIANS, PNEUMONIA, TUBERCULOSIS, DIARRHOEA AND ENTERITIS, MEASLES, AND THE ILL-DEFINED CAUSES (THE LATTER DUE TO DIFFICULTY IN ACCURATE DIAGNOSIS WHEN MEDICAL CARE IS NOT AVAILABLE) PREDOMINATE.

LAST RIDER AND HIS WIFE

SHOWN HERE IN TRADITIONAL BLACKFEET DRESS, STILL BELIEVE THAT THE TEPEE IS AN EXCELLENT TYPE OF HOUSE.

jams and candies. Also among the Chippewa tribes in Minnesota and Wisconsin, with a high caries rate, the subsistence is mainly vegetables and wild rice. The North Dakota Chippewas, however, with a low caries rate, have more milk and meat. Further examples could be given, but these will suffice.

Dental trailers have been introduced in the Service and, roads and weather permitting, have proved of immense value, being in reality completely equipped dental offices on wheels. As in other human ills, dental caries opens a field in research among the Indian people which might well be explored.

Public health progress through health clinics and education and home visits by the public health nurse are developed as rapidly as funds and personnel will permit, and whenever possible it is the goal that these programs gear in with local health services, as furnished by the county and state board of health. It is felt that the states have definite responsibility for the health protection of a racial group within its borders and in cooperation with the Government this plan is in successful operation in some jurisdictions. Many states have designated Indian Service physicians as local deputy health officers, with the reservations open to state health personnel, to assist in control of diseases that know no boundary lines.

And so to-day we find the Indian with a better knowledge of his physical ills and meeting them more successfully than in the past. He can be reassured in the facts that his race is definitely increasing and that his medical services are far above the average seen among the needy whites. There is much yet to be done, but in all these endeavors he is becoming better able to reach the mean level of economic security and to contribute to the public health welfare of the whole country, this in contrast with what he experienced when the white race "discovered" him.

LUMINOUS GEMS, MYTHICAL AND REAL

By Dr. SYDNEY H. BALL

NEW YORK, N. Y.

MARTIUS reports that Bassianus lies dead in "this detested dark blood-drinking pit."

Quintus: If it be dark how dost thou know 'tis he?

Martius: Upon his bloody finger he doth wear
A precious ring that lightens all the hole,
Which, like a taper, in some monument,
Doth shine upon the dead man's earthy cheeks
And shows the rugged entrails of the pit."
—*Shakespeare,* "Titus Andronicus," Act II, Scene 4.

Ancient and medieval histories and the folklore of all time spin many a tale of luminous gems, rubies, garnets, emeralds, olivines and diamonds and even the pearl so bright in many cases as to be a reasonable substitute for a battery of electric light bulbs. The variants of these tales are many, about one hundred being known to the writer.

Some gems indeed do glow in the dark after being excited by friction or heat: if the glow continues beyond the period of excitation, the phenomenon is phosphorescence: if the glow ceases with the excitation, it is fluorescence. Practically all diamonds, if rubbed with a cloth, and a few diamonds, after being exposed to direct rays of the sun, glow in the dark. Again diamonds and white topaz if heated below red heat may phosphoresce. The phosphorescent quality of diamonds when heated by the sun's rays is usually believed to have been first discovered by Albertus Magnus (? 1206–1280) and it was apparently rediscovered by Sir Robert Boyle in 1663. Boyle also found that one diamond when pressed with a steel bodkin emitted light. Praphulla Chandra Ray, however, claims with apparent justice that Bhoja, a Hindoo of the eleventh century, knew that diamonds phosphoresce. Du Fay, in 1735, determined that lapis lazuli and the occasional emerald and aquamarine were luminescent. Wedgewood, in 1792, found that two pieces of rock crystal or of agate, rubbed against one another, phosphoresce. Pott some fifteen years earlier knew of the luminescence of rock crystal. Wedgewood also states that the ruby gives "a beautiful red light of short continuance." Edmond Becquerel, in 1861, reports that ruby fluoresces better than sapphire. Red felspar fluoresces and when some adularia is crushed the powder fairly flames. From the character of the fluorescence produced by cathode rays, the country of source of a genuine ruby can be determined as can the factory from which a synthetic comes. Many other gems glow if treated with ultra-violet, cathode or x-rays, or with radium emanations: but these are all too recent additions to science to have influenced the authors of the myths of luminous gems.

The discovery of the fluorescence of the mineral from which the property gains its name, fluorite, is usually ascribed to Sir David Brewster in 1833. But Philip Skippon[1] states that one Monsieur Lort, of Montpellier, France, a "counterfeiter" of "amethysts, topazes, emeralds, and sapphires" found that on heating "Fluor Smaragdi" "in a pan of coals" and afterwards "putting it in a dark place (it) shines very much: At the same time several other stones were tried but did not shine." Monsieur Lort's

[1] "An Account of a Journey made through Part of the Low Countries, Germany, Italy, and France about 1663–5," "Churchill's Voyages," 1732, Vol. VI, p. 718.

notebooks would make interesting reading to-day. Some fluorspar, particularly the variety chlorophane, is so fluorescent that it becomes luminescent by the heat of one's hand. Gustave Rose, the great German mineralogist, during his travels in Russia is said to have seen among the gravels of the Irtish River, near Krasnojarsk, chlorophane pebbles which shone with brilliancy all night long, merely due to being subjected during the day to the sun's heat. The Reverend C. W. King believed that phosphorescence "must often have attracted the notice of Orientals on entering their gloomy chambers after exposure to their blazing sun and thus have afforded sufficient foundation to the wonderful tales built upon the simple fact by their luxuriant 'imaginations.'" I thoroughly agree that the Orientals must have noted the phenomenon as did undoubtedly many a savage striking quartz fragments together to get fire. While it is therefore not impossible that the inventors of certain of the tales may have been acquainted with the luminosity of gems, in my opinion many of the tales must be of other origin.

Perhaps, however, the discoverer of the luminescence of gem stones may have been an American Indian. In the kivas or shrines of the pueblos of our Southwest, the drum in certain religious ceremonials portrays thunder and in the darkness of the shrine two pieces of quartz rubbed against one another, lightning. A. V. Kidder in the ruins of the Pecos pueblo, San Miguel County, New Mexico, a pueblo long abandoned, found a "lightning stone," a cylinder of rock crystal which was made to revolve in a base with a shallow semi-circular groove, exactly fitting the cylinder. When the cylinder was rapidly revolved on its base, both elements became markedly luminous. Here we have a machine, a highly evolved mechanism, the joint product of the lapidary and the physicist, which we infer to be perhaps 700 years old. The discovery must be many centuries older, probably by an Indian making in some shaded spot an arrow from quartz.

The recital of the principal, and particularly the older, of the folk tales of luminous gems may not be without interest and will suggest whether these tales are of Greek, Roman, Chinese, Hindoo or medieval European origin. The loci of the stories is all Asia, except Siberia, all Europe except Norway and Russia, Borneo, New Guinea, the United States, Canada, certain South American countries and Abyssinia, French Congo and Angola in Africa. I think, however, the American and African myths were introduced by Europeans. The originators of the tales are Hindoos, Chinese, Hebrews, Greeks and Romans, and the European peoples, especially as to the latter, those of the Middle Ages. The earlier tales originated many centuries before the time of Christ and they are still being invented.

Most of the myths center around the carbuncle or ruby, stones not differentiated from one another by the classical and medieval mineralogists, less commonly around other gems, diamonds and pearls and still less commonly around olivine and onyx. Emerald, jade, cat's-eye and marble also appear as the subject of certain tales, as do certain stones which we can not identify, like "aster," "ceraunia," "hibien," "strange stones," the "sleeping stone" and the "stone that attracts stones." The earliest myths center around luminous precious stones (species unnamed), rubies and diamonds, but luminous emeralds, onyxes, pearls and jade have been described for over two thousand years. Strangely enough, fluorspar and certain species of amber, notably that from Sicily, while strongly fluorescent, do not figure in the myths, nor does opal, certain fine examples of which appear to be fairly alive with fire; indeed one fine example is known as the "Fire of Troy." Again lapis lazuli, used

widely as a decorative stone for over five thousand years, is not mentioned, although at least that from Chili phosphoresces when heated below red heat.

We have all, I think, likened the ruddy light of some fine ruby or garnet to a ball of fire, and the Greeks and Romans named them respectively "anthrax" and "carbunculus," each word meaning "glowing coal." Of course from the Greek form our word "anthracite" was derived. Mineralogists still call the beautiful deep-red garnet pyrope ("fire-eyed"). The Hebrew word for carbuncle is "Eqdach," from a root meaning "to light a fire." As to the other stones, perhaps the "fire" of the diamond may be an explanation, and Berthold Laufer notes that the Chinese apply the epithet "ye kuang" ("brilliant at night") to the diamond, an expression which he is inclined to believe originated in the fifth century of our era. Such an explanation can scarcely apply to the emerald and olivine, prized for their color and transparency, or to the pearl, jade, cat's-eye or marble.

Only in China and Japan and among the Jews and the Abyssinians is the pearl luminous. To these wise men of the East, the pearl is a product of the moon or in their mythology represents or is identical with it. Consequently, the night-shining legends of the pearl are logical, and even we to-day can see the similarity of a fine pearl and the full moon at its best. It may be added that after the luminescence of the Bologna stone (impure barite) was discovered by the Bolognese cobbler, Vincenzo Cascariolo, in 1602, it was sometimes called "lapis lunaris," as it gave out in the darkness the light it received from the sun. Imagination, however, was not lacking in the originator of folk-tales any more than in the creator of the latest detective story: scientific phenomenon to a small degree may have been the source of some few of the tales, mnemonic suggestion helped, but imagination predominated, particularly when we find a ruby or a garnet serving as a lighting plant for a large hall. In the Lei-chau peninsula, in Canton Province, famous throughout China for its myths as to thunder showers, after thunder showers "black stones are found emitting light and sonorous sound on being struck." That lightning and luminous stones are not more frequently associated seems strange.

The principal themes of the myths are three in number. First the illumination of buildings, a myth of Hindoo origin, although some of the stories may well have developed independently elsewhere. As variants, we have the lighting of ships, a myth of Hebrew origin and the guiding of lost persons first appearing in Europe in the Middle Ages. Second, we have the gem-mining stories, the gem being located at night due to its light-giving qualities and extracted by day, tales of Greek origin. The third, the serpent or animal theme, is of Hindoo origin: the variant in which the jewel is in the head of a small animal, the carbunculo, is probably a Spanish adaptation of the story and a further variant, that of the Grateful Beast, is probably independently of Chinese and Roman origin.

The writer has elsewhere expressed the belief that the fine gems, the diamond, ruby and sapphire, were first known to the Hindoos between 800 and 600 B.C. About this time appeared the Vishnu Purâna, in which it is stated that Vishnu, in his incarnation as Seshanâga under the name Ananta ("Endless"), "has a thousand heads adorned with the mystical Swâstika and in each head a jewel to give light." The Vedas also hold that the fixed stars have no actual existence, but that the objects which shine by night are couches of gold set with diamonds and rubies on which the inhabitants of paradise repose. The ancient Hindoo book, Mahabharata (perhaps 200 B.C. to 200 A.D.), tells in the story of the Pan-

davas brothers, of the palace of the raja Babhruvâhana with its precious stones that "shone like lamps so that there was no need for any other light in the assembly." In the Buddhacharita (about 100 A.D.) the city of Kapila so shone with the splendor of gems "that darkness like poverty could find no place." So that in India, the earliest country in which fine gems were known, the luminous character of gems was believed in some twenty-five hundred years ago.

Herodotus (approximately 484–420 B.C.) was the first European to describe luminous gems. Two great columns in the temple of Hercules at Tyre, one of gold, the other of smaragdos (green gems including emerald), the latter of which shone with great brilliancy at night, excite his admiration. The wily priests doubtless enclosed a lamp in hollow green glass, to mislead the credulous. "On Rivers" probably written by the grammarian, Parthenius, Vergil's tutor in Greek, in the first century before our era states that in the Sagaris River the "Aster" is found, "which flames in the dark hence called 'Ballen,' the King, by the Phrygians." Pliny in the first century of our era describes the chrysolampis, an eastern gem, "pale by day but of a fiery lustre by night."

The earliest Chinese reference to luminous gems is found in the biography of Li Sen, he who burned the Confucian literature (210 B.C.) under the Emperor Shi Hwang-ti, in which "moon-bright pearls" and a "night shining" jade disk are mentioned.

Talmudic legends (dating from, say, 400 to 600 A.D.) contain rather numerous references to luminous gems: for example, Abraham was so jealous of his wives, and they were not few, that he incarcerated them in a city of iron with walls so high that the poor women saw neither the sun, the moon nor the stars. He generously, however, provided a great bowl filled with jewels which lighted up the whole building.

The best documented of the illumination tales and a characteristic one is that of the luminous carbuncle or ruby of the King of Ceylon, first mentioned by Cosmas Indicopleustes in the sixth century and thereafter described by many travelers, the latest of the seventeenth century. The stone, as big as a pine cone, was in a temple situated on a hill, some state in the Buddha Tooth Temple near Anurajapura. "Its magical brilliance illumines the whole heaven. In the calm of a clear and cloudless night it can be seen by all, even at a distance of 10,000 li" (the equivalent of the old li is so variable that the distance might vary from 3½ to 3,500 miles), says the Chinese Buddhist pilgrim, Hüan Tsang. Others state at night it shines "like a torch"; that it "serves instead of a lamp at night"; that it has "the appearance of a glowing fire" or of that "of a great flame of fire." Due to its luminescence, according to one of these early Chinese travelers, it was called "The Red Palace Illuminator."

In the latter part of the fifteenth century, John Norton, an English alchemist, wrote a poem entitled the "Ordinal or a manual of the chemical art."[2] He proposed to erect over the Thames, at London, a gold bridge, to be lighted by carbuncles set on golden pinnacles, "A glorious thing for men to beholde."

A variant of the illumination theme is that of boats lighted by luminous gems. An old Talmudic legend states that Noah's Ark was illuminated by a carbuncle, and as it shone more brilliant by night than by day, it permitted Noah to tell even in the torrential rains of the flood night from day. According to the Chanson de Roland, dating from the twelfth century, the Saracen ships coming from Africa were lighted by carbuncles. Strangely enough, somewhat over a century ago the idea was incorporated in the Book of the Mormons, sixteen small stones, white and clear,

[2] Elias Ashmole Theatrum Chemicum Britannicum, London, 1652, p. 27.

being touched with the fingers of the Lord so that they might "shine forth in darkness." A stone being placed in either end of each vessel, the Jaredites for the 344 days of their voyage to America had "light continually."

The theme of luminous gems guiding mariners and others originated in Europe in the Middle Ages. The earliest is probably the Scandinavian saga of the Visby garnets. Visby, now but a shadow of the old Hanseatic trade emporium, lies on the island of Gotland, about 150 miles south by east of Stockholm. The ruins of the monastery-church of the Dominicans, St. Nicholas, still stand. In the heyday of Visby's magnificence, huge garnets formed the center of two rose windows on the west gable end of the church, overlooking the Baltic Sea. Sagas say the two gems shone at night as brightly as did the sun at noon and guided mariners safely to the port. The treasures of the Church of St. Nicholas, particularly the garnets, were of such inestimable value that they were guarded night and day by 24 soldiers, and death was meted out to those who approached the church after sundown. In 1361 Valdemar IV, the ambitious and unscrupulous king of Denmark, attacked the town and after a brave defense, it fell. His rich booty, including the sparkling jewels, which he tore from the rose windows, was placed on his own, the largest ship of his fleet. It was wrecked on one of the Karls Islands, and while the king himself was saved, the treasure sank. To-day, in times of calm, devout Gotland fishermen know that the unearthly rose light which wells up from the deeps of the Baltic is but the luminosity of their sacred jewels, now resting on the bottom of the sea.

The wedding ring of the Virgin Mary and Joseph, according to different accounts, set with an onyx or an amethyst or made of a single green jasper was said to have been brought from the Holy Land in 996 A.D. It was placed in the Church of Mustiola, Clusium (modern Chiusi), Italy, and in 1473 transferred to the Franciscan monastery in that city. One of the brothers, Wintherus, a crafty German, stole it. As he fled, night came on: he knelt before the ring, and on promising to return it, it emitted a great light by which he traveled to Perugia. The two cities fought valiantly for the possession of this sacred relic, but in 1486 the Vatican awarded it to Perugia, where it was placed in the Chapel of the Church of St. Lawrence. That matchless raconteur of Western stories, Jim Bridger (do you know his tale of the petrified forest with petrified birds in mid-air with the notes they sing also suspended in the air petrified?), brought the tale to America. A party of whites were so closely pursued by Indians that they perforce hid during the day. For three consecutive nights they traveled by the luminescence of a great diamond in the face of a neighboring mountain.

The mining theme is of Greek origin and was almost simultaneously told a few years before Christ's birth by Diodorus Siculius and by Strabo. The island, Ophiodes, in the Red Sea (present Zebirget) was so called as it was infested with snakes which Ptolemy Philadelphus exterminated so that its olivines, even today the finest in the world, could be mined. Olivine first appears in Egyptian jewelry in the eighteenth century dynasty so that the source was presumably known some 1,500 years before Diodorus's time. The mines were the personal monopoly of the Egyptian king and were worked under the watchful eyes of his representatives. Diodorus says: "All were forbidden to set foot upon that Place: and if any landed there, he was presently put to death by the Keeper of the island. These Keepers were few and lived a most miserable Life; and lest the Stones should be stolen and carry'd off there was not a Ship left

there: and if any by chance pass near these places (out of fear of the King) they sail away as far off as they can." As the island was a barren waste, the miners, provided the provision ships did not arrive, were "driven to the utmost desperation." "The topaz is a transparent stone sparkling with a golden lustre, which, however, is not easy to be distinguished in the day-time," according to Strabo, "on account of the brightness of the surrounding light, but at night the stones are visible to those who collect them." Diodorus more dramatically states the stone "shines bright and glorious in the darkest night and discovers itself at a great distance. The Keepers of the Island disperse themselves into several Places to search for this stone and whenever it appears they mark the Place with a great Vessel of largeness sufficient to cover the sparkling Stone: and then in the Day-time go to the place, cut out the Stone, and deliver it to those that are Artists in polishing of 'em.'" Strangely enough the "topaz" of the legend is in reality our olivine, a stone not luminescent, while the true topaz is. Pliny repeats the same tale about the Carchedonia, probably a garnet from near Carthage; "found they are twinckling against the moonlight and especially when it is in the full."

This tale may well have been told to travelers by astute Egyptian gem merchants anxious to enhance the value of their wares by exaggerating the dangers inherent to procuring the olivines. And yet, to-day, in the tungsten mining industry, the fluorescence of one of its principal ores, scheelite, the calcium tungstate, is turned to advantage at the Mill City mine of the Nevada-Massachusetts Company. Portable ultra-violet lamps for fluoreseing scheelite are used underground in geological work and in sampling the ore. The scheelite usually fluoresces a light blue. Fluorescence is also used in testing the quantity of scheelite in the various mill products. The use of ultra-violet lamps in detecting the amount of willemite (zinc orthosilicate) in the ores and mill products at the New Jersey Zinc Company's mine, at Franklin, New Jersey, has been standard practice since 1906.

There is an old Banian legend, the date of which is unknown to me, that to Shuddery, one of the four sons of the first humans, Pourous and Parcoutee, the first diamond mine was disclosed at night by the admirable brightness of its stones; he believed it fire till he found it "wanted the heate." He and his sons "did afterwards travaile to the myne of diamonds . . . and stored themselves with them which ever since have been merchandize of deere estimation." In the Psysiologus written about 125 A.D. it is stated that the diamond is not to be found in the day but only at night.

In 632 A.D. it is stated that the jade of the rivers of Khutan, Chinese Turkestan, being discovered by its shining in the water at night, was procured at low waters by divers.

A curious adaptation of Strabo's story is given as to the gold of the land of Ishmael, east of Nineveh, in the travels of Rabbi Petachia of Ratisbon (1170–87 A.D.). There "the gold grows like herbs. In the night its brightness is seen when a mark is made with dust or lime. They then come in the morning and gather the herbs upon which the gold is found." Lastly in the middle of the sixteenth century, Benvenuto Cellini tells us that one Jacques Cola found a carbuncle in his vineyard by its shining at night.

That snakes carry either in their forehead or in their mouth a most potent jewel is an almost world-wide legend. The legend reached Europe at least by the time of Christ, but is presumably of Hindoo origin, India being the earliest source of fine gems and a country by no means short of snakes. It has been suggested the myth is connected with snake

worship, but perhaps either the reflection of light on the serpent's bead-like eye or the flame color of certain snakes' mouths may be the origin of the myth. In only a relative few of these legends is the stone luminous, this variant being known in India, Ceylon, ancient Greece, Armenia, and strangely enough among our own Cherokee Indians. The myth has affinities with the dragon, the carbunculo and many of the "animal-gratitude" legends.

The serpent has in his head a gem, probably a ruby, which has the brightness of a lamp according to the Hindoo work, Brhatsamhita of Varahamihira (505–587 A.D.). In one of Somadeva's stories (eleventh century), the hero's submarine wanderings in search of the silver-jeweled tree is lighted by the Mani or precious jewel from a snake's head. The fact that in the "Life of Apollonius Tyanceus," by Philostratus (A.D. 170–245), the Greek states that in India stones endowed with a peculiar luster and a wonderful virtue are taken from serpents' heads, suggests that the myth is an ancient one in India. The author naïvely adds that the stone in the ring of Gyges which permitted him to see invisible things was of this nature.

The Ceylonese to-day, and it is said even some Europeans resident in Ceylon, believe the Kantha jewel is found in the mouth of certain, but by no means all, cobras. It is highly luminous, and when the serpent wishes to find anything in the dark it disgorges the jewel and swallows it again when its object has been attained. To obtain this sovereign gem the snake must not be killed, for that would be bad luck, but one must throw upon the disgorged gem a mass of clay, a bag of ashes, a basket or a cloth. The poor confused snake, no longer seeing his gem, finally disconsolately leaves the locality and the gem may be recovered. The cobra dies of grief or commits suicide. Dr. H. Hensoldt states he saw at night a cobra contemplating such a stone: and that later one given him by a native turned out to be chlorophane. He concludes that the stone fluoresces like a female fire-fly (a delicacy from the cobra's view-point): and that this serves as a decoy for gallant male flies, thus scientifically explaining the myth of precious stones in snakes' heads! The myth reached Persia over a thousand years and in the tale of the Rose of Bakawali, the heroic prince plunged the forest into darkness by throwing a lump of clay on the gem and the miserable snake and a dragon, who carried the snake in its own mouth, knocked their heads against rocks and died.

The Coreans worship the epkuron-gi, a snake, the guardian of their penates, who when of venerable age carries on his forehead a glistening jewel "ya-kang-chin." The name is applied to any glittering stone, especially the diamond. According to Armenian legend the serpents of Mt. Ararat are ruled by a queen who destroys her enemies by a magic stone, the Hul, carried in her mouth. This "stone of light" "upon certain nights she tosses in the air, when it shines as the sun. Happy the man who shall catch the stone as it falls."

The Cherokee have a myth, a variant of the Horned Serpent legend so prominent in Iroquois mythology, that upon the head of the prince of rattlesnakes there glittered a gem of magic powers. This was stolen by a cunning warrior successfully encased in leather armor against a host of poisonous fangs. The stone was held in religious awe and was only brought forth on state occasions. The stone or a substitute, said to have been transparent, was once supposed to be in possession of several medicine men and was used in divination and in medicine. No living Cherokee now has such a stone. The legend, first told by Lieutenant Henry Timberlake, in 1765, suggests European influence.

In some legends largely of Chinese

origin, dragons replace snakes. The old Chinese author Li-Shi-chên describes "thunder-beads" dropped from the mouth of a divine dragon which light an entire house by night. An Emperor of China many centuries ago, according to a legend of the Dusuns, a Bornean tribe with certain Chinese affinities, heard of a carbuncle upon the summit of Kinabalu guarded by a dragon. He sent his three sons to get it, vowing that the successful one would be his successor. The youngest stole the stone, but the enraged dragon finally overtook the robbers and destroyed all the junks except the one on which the three princes escaped to China. The other Chinese survivors, having no means of reaching their homeland, intermarried with the Dusun women. A variant is the love story of Po Kong, a young Chinese, and the daughter of a Dusun chief, who, marrying against the chief's wishes, fled from his village. One night they saw on the summit of Kinabalu a strange intermittent light, as the guardian dragon alternately swallowed and spit out an enormous carbuncle. The young couple got two handfuls of mud with which, when the carbuncle was on the ground, they blinded the dragon. Po Kong seized the gem, wrapped it in his coat and there was instant darkness. Po Kong basely deserted his wife, leaped a deep chasm into which the pursuing dragon crashed, and settled in a Tempassuk district town and became the founder of a local line of chieftains. But of his first wife and the carbuncle nothing more is known. Friar Jordanus, who wrote about 1330, states that the dragons of India Tertia (Eastern African, south of Abyssinia?) have on their heads "the lustrous stones which we call carbuncles." In their ill-advised attempts to fly they crash into a river issuing from Paradise. After seventy days the people recover the carbuncle and take it to Prester John, the Emperor of the Ethiopians. Sir John Chardin, writing after his third visit to Persia in 1686, says the Egptian carbuncle was probably "only an Oriental Ruby of higher Colour than usual." The Persians call it "Iceb Chirac, the Flambeau of the Night because of the property and Quality it has of enlightening all things round it." . . . "They tell you that the Carbuncle was bred within the Head of a Dragon, a Griffin, or a Royal Eagle, which was found upon the Mountain of Caf."

Another variant of the snake story is that of the "carbunculo," apparently of medieval European origin and introduced into America by the Spaniards. In the Embassy of the Abyssinian Patriarch, Don John Bermudez, to John III of Portugal, written in 1565, an animal of the Upper Nile is described "which they call of the shadow because it hath a skinne on the head wherewith it covereth a very precious stone which they say it hath in her head." William Finch reports in about 1608 the same animal in Sierra Leone. "The Negros told us of a strange beast (which the interpreter called a carbuncle) oft seene yet only by night, having a stone in his forehead, incredibly shining and giving him light to feed, attentive to the least noyse, which he no sooner heareth, but he presently covereth the same with a filme or skinne given him as a naturall covering that his splendour betray him not." Shortly thereafter the story is transferred to America although the bearer in the earliest version is a snake. The Carib Indians (Charles de Rochefort, The History of the Caribby Islands . . . Rendered into English by John Davies, London, 1666, p. 15) have for a long time entertained their visitors with a tale of a huge snake living in an inaccessible hollow on the island of Dominica, West Indies. "On its head was a very sparkling stone, like a Carbuncle, of inestimable price: That it commonly veil'd that rich Jewel with a thin moving skin, like that of a man's eye-lid: but that when it went

to drink or sported himself in the midst of that deep bottom, he fully discover'd it, and that the rocks and all about receiv'd a wonderful lustre from the fire issuing out of that precious crown."

In the highlands of Peru and Bolivia near Lake Titicaca and to a less extent on the Peruvian coast and in the Montaña the Indians tell extraordinary stories of the carbuncolo. Some claim to have seen it as at night it slinks through the thickets; an animal the size of a fox with long black hair. If followed, the animal opens a flap in his forehead, disclosing a brilliant precious stone which blinds whoever tries to grasp it. The flap is then let down and the animal escapes. I think we all have been startled at night by the apparent luminescence of animals' eyes. Tshudi states the story antedates the Spanish conquest, that the early missionaries were told of it by wild Indians and that the early viceroys officially instructed the missionaries to spare no pains to obtain the jewel. According to A. F. Bandelier, the carbunculo is a species of cat and the jewel of blood-red color. He adds it is supposed to dwell in the high snows of the peak Sajama near Oruro and that it impedes access to the peak. Notwithstanding the reported age of the myth, I believe that it was introduced by the Conquerors particularly as the Peruvian Indians, while acquainted with many precious and decorative stones, had none that might suggest a luminous object. The existence of the tale among Indians as different as those of Peru and Guatemala is further evidence of the introduction of the story to Latin America by the Spaniards. It should be noted how closely these American versions follow the pattern of the European form.

One of the early groups of legends has as its theme animal gratitude. Luminous gems figure in a number of such tales, which probably originated in China and Rome independently some two thousand years ago.

The earliest of these stories known to me is told by the Chinese philosopher, Huai-man-tse, of the second century B.C. A year after the Marquis of Siu had cured a wounded snake, it returned with a luminous pearl in its mouth. It was an inch in diameter, white, and emitted a light as bright as that of the moon, lighting a room like a torch. The same story is told of the Emperor Ho-ti, the stone in this case being a carbuncle. Laufer cites from the Sou Shên ki the following tale: K'uo i Ts', on having restored to health a crane shot by an archer, released it. One night two cranes—a male and a female—appeared before his door, carrying in their beaks moon-bright pearls to reward him.

The earliest of the Roman forms (AElian) of this legend dates about 222 A.D. and is that of Heraclea, a worthy widow of Tarentum, Italy. She had cured a stork of a broken leg. A year thereafter the grateful bird, as Heraclea sat at the door of her cottage, dropped in her lap a jewel, probably a carbuncle. That night as she awoke she found her chamber flooded with light, the stone shining like a burning torch.

Matthew Paris in his chronicles, written about 1195 A.D., states Richard Coeur de Lion used to tell as a parable the following: a Venetian, Vitalis, was rescued from a horrible death by a ladder being let down into a pit into which he had fallen. A lion and a serpent trapped in the same pit used his ladder to escape, and later the lion in gratitude brought to Vitalis a goat he had killed and the snake a luminous jewel which he carried in his mouth. Later the two animals appeared as his witnesses in a lawsuit which he gained. As Richard is reported to have told the story after his return from the Crusades he may have heard it in the East, as a similar story, without, however, the stone being luminous, is said to occur in the Arabic work, Kalíla wa

Dimna (about 800 A.D.), and the Sanskrit work, Katha-Sarit-Sagara, written by Soma Deva in the twelfth century.

John Gower, writing in the fourteenth century, versifies a similar tale. Bardus, a poor wood chopper, helped from a pit a man, Adrian by name, an ape and a serpent. The man proved ungrateful, but the ape piled up faggots for Bardus, and the snake brought him in his mouth a stone more bright than crystal.

In the introductory paragraphs the early investigators of luminescence have been cited, and in fairness we should praise those who first doubted the exaggerated statements which are the foundation of the above myths. The earliest of these was the Portuguese traveler to India and gem expert, Garcias ab Orta (1563), who, having been told by a jeweler of a luminous carbuncle, doubted its existence. Cleandro Arnobio (1602) had also heard of luminous rubies, but was equally skeptical of their existence. Other doubters were Laet (1647), Robert de Berquen (1661) and Pierre de Rosnel (1668). John Josselyn, Gentleman (New England's Rarities, London, 1672, p. 225–6), after describing a highly luminous stone found by an Indian in New England, correctly adds "But I take it to be but a story." Chardin in 1686 defines the luminous carbuncle as an "imaginary stone," and M. L. Dutens, 1778, adds with a French rapier stroke "such things are not believed to-day." The first to doubt the luminous qualities of the pearl is appropriately a Chinese, Sung Ying-sing, who in 1628 wrote "it is not true that there are pearls emitting light at the hour of the dusk or night."

Luminescence, a property of certain gems and other minerals and one to-day of some practical importance, may well have been observed in India many centuries ago. The myths regarding them, originating in different countries and locally believed even in our day, had their origin however in the main through fancied resemblance of the gems to fire or through symbolic affinities of certain gems to the moon.

THE SHAPE AND SIZE OF THE EARTH

By Dr. WILLIAM BOWIE
U. S. COAST AND GEODETIC SURVEY

THERE are three surfaces of the earth that are used by those who are dealing with problems of geology, geodesy and geophysics. The first, and the one with which we are most familiar, is the actual irregular terrain, high in some places and depressed in others. It is the surface with which we deal in our daily activities. In the matter of its configuration, as referred to the level of the sea, we find elevations as great as 29,000 feet in the Himalayan Mountains and depths of water of as much as 34,000 feet in the area to the east of the Philippine Islands.

The second surface is the geoid or the surface of the waters of the oceans and of imaginary narrow sea-level canals extending through the continental areas. This surface is not one for which a mathematical formula can be written. It deviates in a most irregular way from a simple mathematical figure. But the deviations are due to well-known causes, and to a certain extent they can be predicted. The surface of the oceans moves up and down as the tide-producing forces of the sun and moon operate. When we speak of the sea-level surface we have in mind its average position. This can be determined for any place on the coast by means of tidal observations and has already been done at many places in this and other countries. But there are other disturbances of sea level. The precise leveling results show that for our coasts the surface of the water of the Pacific Ocean is about one-half meter higher than that of the Atlantic Ocean and Gulf of Mexico. This difference is no doubt due partly to differences in the densities of the waters of the two oceans, partly to the effects of winds and partly to differences in average barometric pressures over the two areas. Accurate leveling across the Isthmus of Panama shows that the water of the Pacific is about seven tenths of a foot higher than the water of the Caribbean Sea. What the difference in level is for the waters to the west and east of South America is not known, for no accurate leveling has been extended across that continent. Leveling in Europe, however, indicates that there is some difference in the elevation between the Black and Mediterranean Seas to the south and the waters of the Atlantic and Arctic Oceans to the north and west. The leveling in the United States shows also that there is a slope of sea level towards the north. These deviations of the sea level from a truly level surface are small and must be due primarily to differences in water densities and in meteorological conditions.

The third surface is a mathematical one. It is designed to be a mean of the geoid or sea-level surface. It is in the form of an ellipsoid of revolution with its minor axis coinciding with the axis of rotation of the earth. The intersection of the plane of a meridian and the ellipsoid will be a perfect ellipse. It is the surface formed by turning the ellipse formed by any meridianal plane around its minor axis. This mathematical surface of the earth probably does not deviate more than one or two hundred meters from the actual sea-level surface at any point. The greatest deviations would be in areas occupied by great mountain masses and the deepest parts

of the oceans. The development of the science of geodesy made it possible to determine the dimensions of the ellipsoid, usually called the figure of the earth, with considerable accuracy.

During the dark ages most people considered the earth to be flat, but it is reasonably certain that the opinions of the Babylonians and Greek philosophers that the earth is round had not entirely passed into oblivion. When Columbus discovered the Western Hemisphere the notion that the earth is flat was discredited, but even then the idea of a round earth was not accepted by all. Even today there are cults that will not accept the idea of a spherical surface of the earth.

From the time of Columbus to that of Newton most learned men held to the spherical shape of the earth. Newton was of the opinion that the law of gravitation, which he discovered and propounded to the world, called for a shape of the earth's surface which would be an oblate ellipsoid. It required a longer radius at the equator than at the poles. Newton's announcement created a stir in scientific circles and a controversy that was only settled by the measurement of arcs of meridians in Lapland in high latitudes and in Peru at or near the Equator. It is evident that if the shape of the earth is that of an oblate ellipsoid, the length of a degree of latitude at the equator will be shorter than will be a degree nearer the poles. The measurements made in Lapland and Peru substantiated Newton's views. That epoch-making geodetic work was done by expeditions sent out by the French Academy of Sciences. It was begun in Peru in 1735 and in Lapland during the following year.

The proof of Newton's theory as to the shape of the earth led to the measurement of many other arcs of meridians. Each additional measured arc made it possible to determine with greater accuracy the figure of the earth. Among the famous men who have determined the figure of the earth may be mentioned Airy, Bessel, Clarke and Hayford. Their results have been extensively used in charting the oceans and mapping the island and continental areas and in scientific research.

In order to determine the figure of the earth, it is necessary to measure the distances between places on the earth's surface at which astronomical observations for latitude and longitude have been made. The distances are determined by triangulation. In the early days of the sciences of geodesy and astronomy it was difficult, and in fact impossible, to determine differences of longitude with the requisite degree of accuracy. In consequence the early figures were based on astronomical latitudes only. The difficulty with longitudes was overcome when wire telegraphy came into use shortly before the middle of the nineteenth century. By means of the telegraph the local times at two distant places could be compared and the difference in their longitude derived. Recently the determination of the longitude of a place with respect to a base station has been greatly facilitated and simplified by the use of radio time comparisons.

For many years astronomers have made observations on the stars from which their positions in the heavens can be predicted for any time in the near future. The star catalogues prepared by the astronomers are used by the geodesist in his determination of latitude and longitude, and these serve as control for the extension of great networks of arcs of triangulation.

According to Norlund, of Denmark, triangulation was first used by Tycho Brahe, the famous astronomer, in 1578 when connecting his observatory at Uranienborg with the church towers in

Copenhagen, Helsingfor, Lund and many other places. He also measured a base line to control the lengths of the sides of his triangles. This triangulation was of low accuracy, for it was done before the invention of the telescope.

The first triangulation that may be classed as of high accuracy was that of Picard in France, begun in 1669, for which he used instruments for measuring horizontal angles that had telescopes, spider threads and microscopes. From Picard's time to the present, great progress has been made in the development of instruments and methods used in this class of work.

Triangulation is based on the simple mathematical principle that one can compute the lengths of the two other triangle sides if the length of one side and the values of two of the angles are known. In actual practice all three angles of the triangles are measured, and only occasionally is the side of a triangle actually measured as a base since a computed side can be used as the known length of a succeeding triangle. The bases vary in length from five to fifteen miles, depending upon the terrain. The measuring is done with invar tapes or wires. The probable error of the length of a base is seldom greater than one part in one million, or about one sixteenth of an inch per mile. The error of a measured angle is seldom as great as one second of arc.

An arc of triangulation consists of a continuous chain of triangles. One side of the first triangle is used as the base of the second one, and in turn each triangle depends for the lengths of its sides on the length of a side of a preceding triangle. Bases are measured at intervals of from ten to twenty triangles, as a check on the accuracy.

In areas of high relief the theodolite, used for measuring the angles of the triangles, is supported by a low stand, but in terrain of low relief, steel or wooden towers must be used to elevate the instrument to such heights as will enable the observer to see the other stations that form the triangle. The objects sighted on are electric lamps placed over the stations as it has been found that observations made at night are more accurate than those made during daylight. Formerly, observations were made in daylight on heliotropes, whicl. consist of mirrors illuminated by sunlight.

The longitude of each triangulation station may be computed on the adopted ellipsoid or figure of the earth. The ellipsoid used in this country is that of Clarke of 1866. At intervals of from six to ten triangles the astronomical longitude and azimuth at a triangulation station are observed in order to control the azimuths or directions of the triangulation lines. While a single astronomical station may serve as the initial station for a triangulation system, yet it is desirable to have many astronomical stations in order to fix the triangulation system in its most probable position on the surface of the earth. The triangulation net of this country has about 67,000 miles of connected arcs of triangulation and astronomical latitudes, longitudes and azimuths determined at many hundreds of the stations. It will be possible for a new and more accurate figure of the earth to be derived from this great mass of geodetic data. This is a task for the officials of the Coast and Geodetic Survey, and no doubt they will undertake this very important work as soon as additional funds and personnel are furnished them.

In deriving a new figure of the earth the mathematician uses the differences in the latitudes and longitudes of the triangulation stations as derived from the astronomical observations and as derived from the computations of the triangulation. If there were no irregularity in the actual surface of the earth and if

there were no horizontal irregularities in the distribution of mass of the earth, the differences of the astronomic and geodetic positions of the stations would be due solely to the accidental errors of the triangulation and astronomical measurements and to the deviation from the truth of the adopted figure of the earth used in making the geodetic computations. Under these conditions the dimensions of the ellipsoid derived for the area of some one country, such as that of the United States, should be about the same as those obtained from the data in other large areas.

Conditions are not so simple as those outlined in the preceding paragraph. The irregular surface of the earth has the effect of influencing the direction of the plumb line to which all astronomical observations are referred. For example, the plumb line will be deflected to the west at stations to the east and close to a mountain range. At stations on the coast of a continent the deflection will ordinarily be toward the land and away from the ocean. Even low ranges of hills deflect the plumb line from the direction that is normal to the ellipsoid. With good maps and charts one can compute and allow for the influence of the topography on the direction of gravity in determining the astronomical positions of triangulation stations.

The topography, as is well known, is the mass above sea-level and the deficiency of mass in the oceans and seas. But there is another disturbing influence. It is the compensation, within the outer shell of the earth, of the topography. Under the continents the density of the shell materials is less than normal, while under the oceans the shell matter is greater than normal. The normal densities are for the shell under the coastal planes. The shell of the earth within which the compensating excesses and deficiencies exist extends to a depth of about 60 miles below sea-level. The higher the elevation the greater is the deviation from normal density in the shell below. It has been found that the pressure exerted by any large portion of the shell on the 60-mile surface is practically the same as that for any other portion of the shell of the same horizontal extent. At least it is safe to assume that this is true, for many tests made in widely separated parts of the earth bear it out. The shell of the earth is in a state of approximate equilibrium, a condition that was termed "isostasy" by the great geologist, C. E. Dutton. Isostasy may be defined simply as equal pressure.

The isostatic condition of the earth must be taken into account if the best results are to be obtained in the derivation of the dimensions of the earth from astronomical and geodetic data. This was done by Hayford when he derived the dimensions of the earth from data in this country. This is why the International Geodetic Association considered Hayford's values the most accurate ones and adopted them as the international standard in 1924.

The dimensions of the International Ellipsoid of Reference, based on Hayford's work are:

Equatorial radius = a = 6,378.388 kilometers
= 3,963.34 statute miles
Polar radius = b = 6,356.914 kilometers
= 3,949.99 statute miles
Flattening = $f = \frac{a-b}{a} = \frac{1}{297}$ exactly.

It would seem that the dimensions of the earth derived from data secured in one continent should be the same as those obtained from data from any other continent, provided isostasy were taken into account in both areas. This is no doubt close to the truth, but it is quite certain that the distribution of compensating densities in the shell of the earth is somewhat irregular and that the compensation

is not always perfect. In consequence, the computed effect of the compensation on the astronomical determinations of latitude and longitude will be somewhat in error. But this error is small, and although the dimensions of the earth derived from data in different parts of the earth will not be the same, they will be very close together. They will agree much more closely than dimensions obtained without taking isostasy into account.

For research on the figure of the earth and to consider other branches of the science of geodesy there was formed many years ago the International Geodetic Association. At the time of the world war about thirty countries were adhering to that organization. The science of geodesy has to deal with problems that are world-wide and therefore cooperation of the workers of many countries must be facilitated. At present there is a new geodetic association, one of the branches of the International Union of Geodesy and Geophysics, to which about thirty-five countries are adhering. The union has been invited to hold its triennial convention in Washington, D. C., in September, 1939. The last convention of the union was held in Edinburgh, Scotland, in 1936. The American Geophysical Union, a branch of the National Research Council, is the organization of this country that deals with the international phases of the sciences of geodesy and geophysics and with the International Union.

THE HANCOCK PACIFIC EXPEDITIONS[1]

By Dr. HUBERT LYMAN CLARK

CURATOR OF MARINE INVERTEBRATES, MUSEUM OF COMPARATIVE ZOÖLOGY, HARVARD UNIVERSITY

THE recent gift of Captain Allan Hancock to the University of Southern California establishing the "Allan Hancock Foundation for Scientific Research" has attracted renewed attention to the work of the Hancock Expeditions of the past seven years. It is unfortunate that the scientific world has as yet little realized what these expeditions have accomplished or what the possibilities of the new foundation are. It is desirable therefore that a definite account of these expeditions should be presented to the readers of the SCIENTIFIC MONTHLY.

The present series of Hancock Pacific Expeditions began in 1931 and have been repeated each year, the seventh having just returned from San Juan Bay, Peru, the southernmost point as yet reached. The area which the expeditions have explored may be briefly designated as the eastern tropical Pacific. The American coast from Los Angeles to southern Peru has been extensively visited, and many outlying islands, notably Cocos and the Galapagos Archipelago, have served as bases for much biological collecting. While marine zoology has been the chief field of research, the land and fresh-water faunas of places seldom visited by scientists have not been neglected, nor has botanical research been ignored. From the start the work has been carried on in close coöperation with the zoological department of the University of Southern California, but on each expedition there have also been zoologists or botanists from other institutions, notably the United States National Museum. The remarkable success of the expeditions is undoubtedly due to the unusual spirit of coöperation inspired by Captain Hancock's wise leadership and the enthusiastic industry engendered by his constant consideration and generosity.

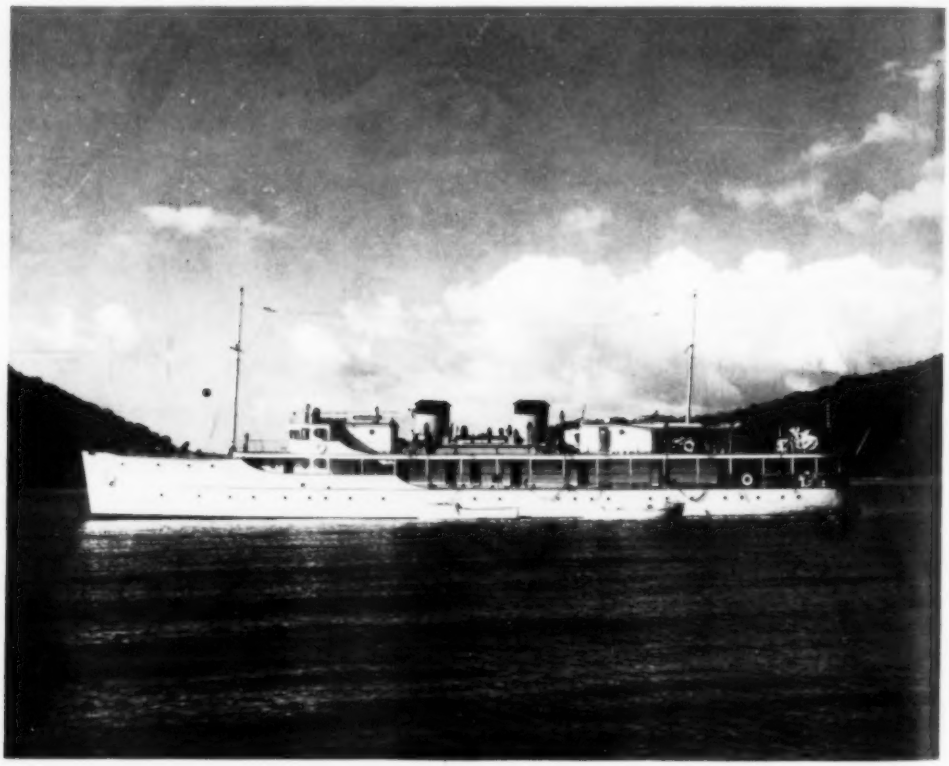
Naturally the vessel which has made the expeditions so successful is of prime interest in discussing them. For many years Captain Hancock has been an ardent navigator and a lover of the sea. Before the war, cruising in a small boat which he named the *Velero* (Spanish for "swift sailing") was a favorite occupation. The experience so derived led to the remodelling and enlarging of the boat, but even so, she was soon replaced by a larger vessel, the *Velero II*. But becoming convinced that a still larger boat, specially designed for long cruises such as scientists desired to make, was essential, Captain Hancock, with his chief officer, Mr. W. Chas. Swett, planned and supervised the building of his present cruiser, the *Velero III*. She was launched in the spring of 1931 and sailed on December 3rd of that year on the first of the Hancock Expeditions, to the Galapagos Islands and the western coast of tropical America. In the fall of 1927, Captain Hancock had visited the Galapagos Islands on a scientific cruise and it was due to the experience he gained thereby that the *Velero III* was so well adapted from the very first to her work in marine zoology and exploration. Although but 195 feet in length and having a net displacement of only 293 tons, she

[1] Annual cruises of Hancock Expeditions have been made on the *Velero III*. The vessel was built in 1931 and fully equipped as a floating laboratory. Photographs are reproduced with this article through the courtesy of Captain Allan Hancock. They were taken by W. Chas. Swett, who has been a member of the expeditions since their inception.

rides the waves with wonderful steadiness, and has proved herself through seven years of service a most comfortable home, even for the landlubbers who comprise so large a part of the scientific staff. Her Diesel engines are powerful enough to enable her to cover nearly 300 miles a day, while all other operations for light, heat, ventilation, etc., are performed by electricity. The ventilating system is so nearly perfect that though the port-holes may not be opened during the whole cruise, the air in every room is as fresh and pure as that on the decks.

The equipment of the boat for work in marine zoology is complete, so that there need be no loss of time in either the collecting or caring for the material sought. Running salt and fresh water is always available and alcohol and other preservatives and reagents are amply provided. Seven years' experience has led to a perfection of detail in provision for the unexpected that is most unusual. Mr. John S. Garth, of the University of Southern California, has been on every voyage of the *Velero III* and has become an invaluable adviser and director of the scientific work. It is due in large measure to his unusual qualifications for the task that the work in marine zoology has been so successful.

The *Velero III* is now equipped with a large dredge and more than a thousand fathoms of wire cable so that collecting in deep water is possible, but most of the dredging is done from one of the five motor launches which the vessel carries.



THE *VELERO III*,
CAPTAIN ALLAN HANCOCK'S FLOATING SCIENTIFIC LABORATORY, AT ANCHOR OFF TROPICAL SHORES OF PORT UTRIA, COLOMBIA, SOUTH AMERICA.

SPECIAL DEEP-SEA DREDGING GEAR

CAPABLE OF SAMPLING THE BOTTOM OF THE OCEAN AT DEPTHS OF A MILE OR MORE. A POWER WINCH REELING 7,000 FEET OF SPECIAL CABLE IS SHOWN WITH OPERATING CONTROLS.

at least two of which, plus two or three rowboats, are in constant use whenever the *Velero* is anchored. The dredging launch carries two hundred and fifty fathoms of wire cable, on a winch, which is directly connected with the engine, so that all handling of the dredge is done mechanically with rapid efficiency. Of course, there is also every facility provided for shore collecting either by dip nets or by hand, and there is ample equipment for exploration and all sorts of collecting on land. Nothing has been overlooked which can facilitate effective work in either zoology or botany.

The personnel of the expeditions has varied with each year, but for the most part has been sufficiently constant so that a real continuity runs through all seven expeditions. Captain Hancock has led them all, while the chief engineer and many members of the carefully chosen and highly efficient crew have always been along. The guests include an artist, a doctor (usually the genial and capable Dr. E. O. Palmer, of Hollywood, a long-time friend of the captain), and a photographer, but it should be added that the chief officer is a past grand master in the photographic art, as the accompanying illustrations amply testify, and most of the notable photographic work accomplished, both still and moving pictures, is the result of his skill. These remarkable films and photographs are available to all educational and research institutions which desire to make use of them.

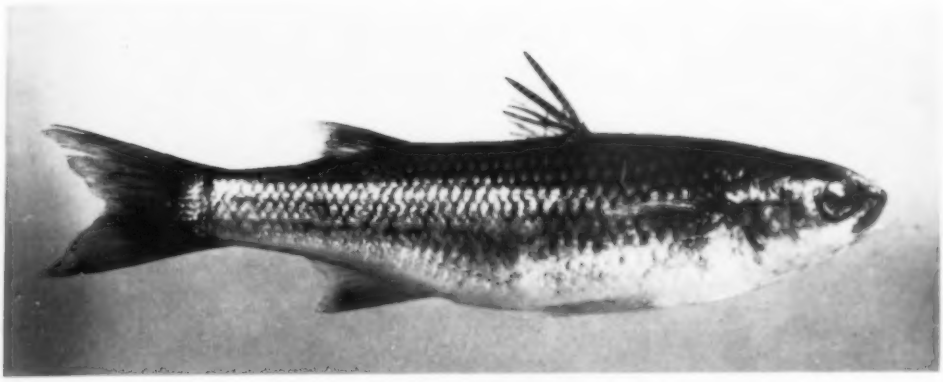
The actual zoological work of the expeditions is closely tied up with two of

SCIENTISTS ABOARD THE *VELERO III*

EXAMINING A DEEP-SEA DREDGE HAUL ON SPECIAL PLATFORM LASHED ON BOW OF CRUISER. LEFT TO RIGHT, AROUND THE TABLE, ARE: DR. HUBERT LYMAN CLARK, HARVARD UNIVERSITY; ALEX HILL, UNIVERSITY OF SOUTHERN CALIFORNIA; JOHN S. GARTH, UNIVERSITY OF SOUTHERN CALIFORNIA, AND DR. GEORGE S. MYERS, STANFORD UNIVERSITY.

southern California's great institutions—the University of Southern California and the San Diego Zoological Park. One of Captain Hancock's notable traits is his great love for animals and his association with the San Diego Zoo is therefore most natural. As a member of the board of directors of that institution, he has its interest always in mind and generally one or more of its curators accompany the expeditions. But whether or not such a representative is aboard, the *Velero III* always brings back living animals for the Zoo. On the voyage just completed, the upper deck aft was crowded to the limit with the cages of more than a hundred living mammals, birds and reptiles. This interesting menagerie included a huge tortoise and many large iguanas from the Galapagos Islands, penguins, condors and vultures from Peru, pug-nosed seals from the same country, spectacled bears, marmosets and monkeys from Ecuador, and a big crocodile and a capybara from Panama. Captain Hancock's constant interest in and attention to these, his pets, assures them of the best care, and comfortable, even though restrained, freedom in their new and beautiful home.

The association of the University of Southern California with the zoological work of the expeditions has been close from the very start. Professor Irene McCulloch and her students have been constantly at Captain Hancock's service.

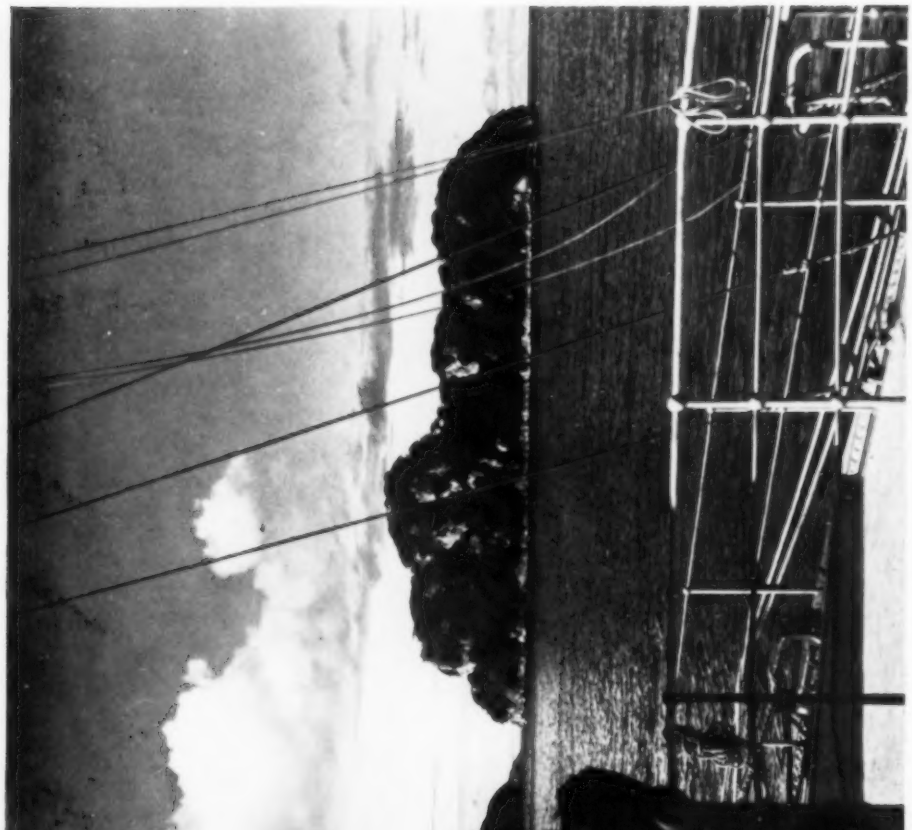


FRESH-WATER MULLET

CAPTURED IN A SPRING-FED STREAM ON CHATHAM ISLAND IN THE GALAPAGOS ARCHIPELAGO AND NAMED AGANOSTOMUS HANCOCKI SEALE, IN HONOR OF CAPTAIN ALLAN HANCOCK. ITS NEAREST RELATIVES ARE FRESH-WATER FISH OF THE CENTRAL AMERICAN MAINLAND.

A LARGE SPECIMEN OF THE FAMED LAND TORTOISE

FOR WHICH THE GALAPAGOS ISLANDS WERE NAMED, ON INDEFATIGABLE ISLAND IN THE EQUATORIAL ARCHIPELAGO. SEVERAL OF THIS SPECIES OBTAINED BY HANCOCK EXPEDITIONS HAVE BEEN PLACED IN THE SAN DIEGO ZOOLOGICAL GARDENS AT SAN DIEGO, CALIF.



TROPICAL SHORES OF COCOS ISLAND,

OFF THE COAST OF COSTA RICA, LOOM ACROSS THE BOW OF CAPTAIN ALLAN HANCOCK'S EXPLORATION CRUISER, VELERO III. MANY VALUABLE SCIENTIFIC SPECIMENS WERE OBTAINED IN THIS REGION BY THE 1938 EXPEDITION.

Dr. McCulloch has supervised the storage and study of the collections as they come in from year to year, while at least two of her students, in addition to Mr. Garth, have accompanied each voyage. These young men, particularly Fred Ziesenhenne and Alex Hill, have become expert collectors of marine animals and past masters of the art of preparing and labeling such material. Moreover, students interested in birds and insects have made, on one occasion or another, important collections in those groups, which are now awaiting study in Los Angeles. On each voyage some older zoologist or botanist, or both, have been guests of Captain Hancock, and special effort has been made to give such men exceptional facilities for collecting and studying material in their special fields. These men have represented the United States National Museum, the University of Michigan, the University of British Columbia, Stanford University, the California Academy of Natural Sciences, the Steinhart Aquarium and the Museum of Comparative Zoölogy. They have had a wide range of interests and each has been most enthusiastically grateful for the privileges he has enjoyed.

The seven expeditions have covered a very large area in the eastern tropical Pacific, but those of 1936 and 1937 were devoted to the Gulf of California and the adjoining Mexican coasts. In 1934, the outlying islands of the Revillagigedo group, notably Socorro and Clarion, were visited and even the isolated Clipperton Island was given a brief examination, on the way to the Galapagos. The other four expeditions have explored the marine fauna of the Galapagos extensively, while by no means neglecting the land animals. All the islands, with the exception of Culpepper, which lies far off to the northwest, have been visited at least once, while Albemarle, Charles, Chatham, Indefatigable and James have each been visited five times. Cocos Island, one of the loveliest spots in the Pacific, has had three visits, and has proved to be the home of an abundant and remarkable marine fauna, with a number of apparently endemic species. On the South American coast, Ecuador has been visited three times, with a long enough stay at Guayaquil to permit inland visits to the Andes and once to Quito. The coast of Peru has been a collecting ground twice, with visits to Lima on each occasion. In 1935 the famous "bird islands" were visited, and in 1938, San Nicolas and San Juan Bays served as the base of several days collecting. Returning northward, Independencia Bay, with its interesting penguins, and half a dozen of the "bird islands" with their incredible flocks of sea-birds, gave an ornithological touch to the cruise. On all the expeditions, save those of 1936 and 1937, Balboa has been a port of call, with the possibility of visits to the famous Barro Colorado laboratory in Gatun Lake. Along the coast between Panama and Los Angeles much shore collecting and dredging has been done, at various well-chosen spots and great additions have been made to our knowledge of the fauna of that extended coast line.

The tangible results of the Hancock Expeditions are as yet chiefly visible in the laboratory of the zoological department of the University of Southern California, where a really marvelous collection of marine invertebrates has been built up. No effort is spared in making it possible for the *Velero III's* scientific staff to collect and preserve large series of specimens. As a consequence the collections now waiting critical study at Los Angeles are of extraordinary value, not only for the quality of their preservation, but for the long series from early youth to old age, making possible the investigation of many problems associated with growth and development. As yet publications based on this material are not numerous or extensive but nearly twenty reports, four of which are botanical, have been issued or are in press, while various other reports, some of which will be very extensive, are well

OFF THE COAST OF COSTA RICA, 1932a ACROSS THE BOW OF CAPTAIN ALLAN HANCOCK'S EXPLORATION CRUISER, VELERO III. MANY VALUABLE SCIENTIFIC SPECIMENS WERE OBTAINED IN THIS REGION BY THE 1938 EXPEDITION.

A FINE SPECIMEN OF LAND IGUANA

(CONOLOPHUS SUBCRISTATUS) PHOTOGRAPHED IN ITS NATURAL HABITAT ON SOUTH SEYMOUR ISLAND IN THE GALAPAGOS ARCHIPELAGO. MANY OF THESE SPECIMENS HAVE BEEN RETURNED BY HANCOCK EXPEDITIONS FOR EXHIBITION IN THE SAN DIEGO ZOOLOGICAL GARDENS AT SAN DIEGO, CALIF.

under way. With the new Hancock Foundation building, equipped and staffed, the progress of research on the great collections will receive new impetus. The intangible results of Captain Hancock's enthusiastic efforts to increase our knowledge of the life of the Eastern Pacific, along the coasts and among the islands of western tropical America, are less easy to formulate but are no less valuable. Obviously he has greatly stimulated interest in the work to be done and the problems to be solved. He is developing a group of young zoologists whose future work will be of great importance and he is providing the necessary facilities for the pursuit of their studies. By his unusual wisdom, unassuming but keen interest and able coöperation, he is creating and developing a center for biological research which will bring added renown to American science and be a permanent stimulus to the study of oceanic life.

SOME PHASES OF HUMAN RESPONSE IN THE FRENCH ALPS

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Introduction

We live in an age of specialization and machine-made goods, yet many of the things we use are still made by hand, because mass production methods are not without their serious disadvantages in spite of their many advantages. The United States, with only 7 per cent. of the world's population, produces some 50 per cent. of the world's manufactured goods, yet Americans are not necessarily more ingenious than Europeans or Asiatics. Climatic, economic, psychological conditions—to mention only a few—are extremely favorable for mass production in the United States. For example, the cheap cotton glove sold in five and ten cent stores, for use generally by workmen, is a product that lends itself to mass production methods. There are several reasons for this: cotton products are cheap because cotton is grown and manufactured under almost optimum conditions in the South; the standard of living in the United States is relatively high; Americans are accustomed to buying new articles as soon as the old ones show the first signs of wear—whether it be a question of gloves or automobiles. It would be difficult, for instance, to sell a European a cheap automobile on the ground that it might be out of style or would begin to need repairs at the end of a year, so that he could simply trade it in for a new one; yet this kind of sales talk is an inducement to prospective buyers in America.

However, conditions are entirely different in the *kid* glove industry. There are three essential steps in the making of a kid glove: the preparation of the skin (removal of the hair and fleshy parts, tanning) dyeing (Fig. 1) and the final operations of cutting and sewing. Every skin is different in size, texture, defects, etc. No cutting machine can be made which will serve for thousands of skins, because each skin must be carefully evaluated as to size and number of gloves that can be cut from it. A defect in one corner, for example, would make it impossible to cut more than one large glove from the skin. Consequently this work, as well as such tasks as sorting, matching, sewing thumbs, etc., must be done by hand. Such an industry, therefore, must be located where labor is plentiful, and labor is often abundant in mountainous regions, where, as the population increases, the birthrate is checked, emigration is resorted to or industry is intensified. Often all three controls are operative simultaneously, yet, depending on certain variables, one may be more powerful than the others. In many of the mountainous areas of Europe, as the struggle with the harsh environment becomes more bitter, intensification of industry is resorted to by the inhabitants. To rather simple mountaineers, passionately attached to their soil, this might seem to be by far the easiest solution.

Chapareillan (Fig. 2), a peaceful little village in the broad Gresivaudan Valley, seemed to be a favored place for an intensive study of a family whose income was in part derived from household industry. Monsieur R. and his wife were kind enough to give detailed information as to the sources of the family income.

Household Industry

Madame R. sews gloves. She has specialized in sewing the fingers and

FIG. 1. A SMALL ESTABLISHMENT ON THE OUTSKIRTS OF GRENOBLE FOR THE DYEING OF KID SKINS

THE OWNER, A MASTER CRAFTSMAN, EMPLOYS ABOUT TEN WORKERS.

thumbs, while her neighbor sews in the ridges or patterns on the back of the gloves. Six months of apprenticeship are necessary before passable work can be done, two years before flawless work can be turned out. Madame R. tries to spend about eight hours a day four to six days a week at her work. In summer she works from five to eight or nine A.M., and from two or three to seven or eight P.M.—thus taking as much advantage as possible of daylight. The rest of the time she spends at her housework or in the kitchen garden. She can finish about two pairs an hour, at one franc fifty per pair. On an average she makes a minimum of two hundred and fifty francs a month.

Agricultural Activities

Monsieur R. is a gardener, who earns on the average about twenty-five francs a day for some twenty days a month. He boards at home, but is given all the wine he wants where he works—two or three liters a day in the summer time. On his own plot of six hundred square meters he raises potatoes, corn and beans, for home use, as well as feed for the hares. From ten to fifteen hares are kept on hand all the time (there were eleven in July, 1937). One is eaten every two or three weeks (fifteen to twenty a year). Meat of any kind is a luxury enjoyed usually not more than once a week. In addition to this small plot of rich valley land Monsieur R. has a vineyard of two thousand square meters, which is located at about a ten minutes' walk from his house. It is on a slope well exposed to the sun. In a good year the vineyard yields thirty hectoliters of wine, in a poor year not more than seven. A liter sells at from fifty centimes to one franc fifty—wholesale—depending on the year. He makes no money on the wine in poor years, since seven hundred liters are

necessary for home consumption, but he has made as much as two thousand francs from his vineyard in good years. Apple, fig, peach, cherry and walnut trees add their produce to the family larder.

Thus the total cash income is some nine or ten thousand francs—the equivalent of from three to five hundred dollars, depending on the purchasing power, which fluctuates constantly. This is not a great amount, but it is more than thousands of other families make. Furthermore, because of the self-sufficiency of the family along many lines, this is not so inadequate as it may at first seem.

Educational and Social Aspects

The only child in the family is a daughter, fourteen years old. She now attends a primary school, where a few higher courses are given. The nearest high school, or *lycée*, is at Chambery—15 kilometers away. If she should commute daily on the bus, it would cost five francs a day; to live there would cost three hundred francs a month, even if she came home Thursdays and Sundays. Thus the people in small villages are hard pressed to find the means of sending their children to high school. And besides, as her father said, "with a daughter, of all things, what can one do?" Her education would cost him twenty thousand francs, so he would rather save the money as he went along, lend it out at interest, and thus accumulate a dowry for her. What chance has this attractive, intelligent girl in the world? Very little at best. She will probably become a *gantière*, like her mother, and be the main support of her parents in their old age. Her dowry and her father's small holdings may make her desirable enough for some energetic young peasant to take

FIG. 2. CHAPAREILLAN ON THE NORTH SIDE OF THE BROAD VALLEY OF GRESIVAUDAN

THE SLOPES IN THE FOREGROUND, WHICH ARE WELL EXPOSED TO THE SUN, SUPPORT VINEYARDS, WHEREAS THE SHADED NORTHERN SLOPES ON THE OTHER SIDE OF THE VALLEY ARE LARGELY IN HAY OR PASTURE. THE LONG NARROW GRAIN FIELDS OCCUPY THE VALLEY FLOOR.

FIG. 3. SEWING GLOVES IN THE NARROW STREETS OF LA PALUD, JULY 14, 1937

FIG. 4. OLD IVY-COVERED HOUSE OF MONSIEUR R—— IN CHAPAREILLAN
A NEIGHBOR IS TAKING ADVANTAGE OF THE SHADE FOR HER SEWING.

FIG. 5. THE SMALL RURAL VILLAGE OF NARBONNE

LOCATED IN THE CENTER OF A FERTILE MOUNTAIN TERRACE. THE PEASANTS WHO LIVE IN THIS VILLAGE, WHICH GREW UP AROUND A SMALL CHATEAU, ARE ENGAGED IN AGRICULTURE AND HOUSEHOLD CRAFTS. THERE IS NO STORE THERE, SO THEY DO ALL THEIR TRADING IN GRENOBLE. IT IS IN SUCH PEASANT VILLAGES THAT INDUSTRY OF THE HOUSEHOLD VARIETY IS MOST HIGHLY INTENSIFIED.

her in marriage. He will thus add some square meters of land to his own, and if he is lucky, his son will inherit the few acres and carry on the tradition.

Trends in Agriculture

Monsieur R. explained that a property worth five thousand francs may be made to keep a family of four or five members at the lowest level of subsistence, while a property valued at fifty to sixty thousand francs will bring in from ten to fifteen thousand francs. In a family of five children it is becoming almost necessary for three of them to seek work elsewhere. Even those left on the land may be forced to sell after a year or two of poor crops or of low prices because of bumper crops. With the introduction of machinery many workmen have left the countryside, and many vineyards have been abandoned altogether—particularly those which require all hand labor. Those who can survive on the land buy up the farms of those who must leave, thus large properties are taking the place of small ones.

Increase of Industry with Decrease in Soil Productivity

Chapareillan is just at the foot of the mountain, between the rich agricultural land of the valley and the poorer mountain slopes. It is noticeable that the making of gloves becomes more widespread as the productivity of the soil decreases. More people work at some phase of the glove industry in Chapareillan than on the rich valley floor, and as one continues up the mountain the industry increases in importance in the local economy. On July 14 the mountain ham-

let of La Palud was visited. It was a beautiful day; the sky was as blue as that along the Mediterranean, and the air was so clear that Mont Blanc was easily visible to the east. Whereas in even the smallest village in the valley very little work was being done, in this tiny hamlet there were seven women busy sewing gloves. They sat in front of their solidly constructed cottages (Fig. 3)—in which the live stock is also housed—sewing or knitting as they talked. In the narrow crooked streets were piles of tree branches to be used as firewood, great heaps of manure and an occasional worn-out farm tool. Chickens scratched nonchalantly in the streets. The request to take a picture was granted with a polite nod. Work was not stopped for a moment; it is expensive to work by artificial light, though so much of that is necessary in winter. The men were in the fields busy with the harvest; they could not afford to lose such a day in celebration, even on Bastille Day.

Conclusion

The conditions pictured in the foregoing paragraphs exist in many parts of Europe. Household industry seems so firmly anchored among the frugal hard-working people of the densely populated mountain areas that it would appear difficult for the inhabitants of more favored regions to compete with them. But only those articles that can pay their transportation costs to distant markets because of their relatively high value in proportion to weight or volume can be produced in these areas. Swiss watches and cheeses are good examples. Frequently, the people of one region will specialize in luxury goods which are almost wholly dependent upon foreign markets, and which may be among the first things foreigners will do without in the event of a depression. Unfortunately, such industries are often at the mercy of foreign legislators who have the power of erecting tariff walls. The French kid glove industry might easily suffer the same fate as the Swiss watch industry—which began as a household craft. Many Swiss watch-making establishments closed down permanently as a direct result of the United States Tariff Act of 1930. Men who had spent a lifetime acquiring the delicate skill required to engrave watch cases, or to make fine springs or screws were forced to lose this precious capital—perhaps irretrievably—by taking any work they could get—even day labor. Similarly, a tariff on kid gloves, behind which the workers of other countries could compete with the French, would disrupt the economy of a large part of the population of Grenoble and its environs. Thus twentieth-century man creates with one hand the best network of communications the world has yet known, yet with the other nullifies its effect by tariff walls which are as effective as barbed wire entanglements in stopping the flow of trade.

SCIENCE AND SOCIETY IN ANCIENT ROME

By Dr. WILLIAM SALANT

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THE economic interpretation of history and politics which is associated with the name of Marx has also been extended by his followers to the history of science. According to this view, of which Hessen[1] is the strongest living protagonist, the development of science is explained in terms of economics, by which is meant that the needs of mankind to provide for its existence furnish the stimulus to scientific investigation. Science is thus necessarily rooted in industry, agriculture and exchange of commodities. Hence a society which is distinguished for its practical achievements is regarded by some historians and sociologists as a necessarily favorable soil for the development of science. It is probably due to this assumption that led Bukharin,[2] the noted Marxian economist and sociologist, to speak, in one of his works, of Rome as one of the nations of antiquity that contributed so much to the progress of science. Substantially the same conclusion is implied in a recent address by Sigerist,[3] eminent as a historian of medicine and science, who stated that Alexandria and later Rome were centers of scientific research.

These statements contradict the conclusions of other recognized workers in this field. According to Sarton,[4] who is the foremost living historian of science, "Roman science at its best was but a pale imitation of the Greek." "The Romans," he continues, "were so afraid of disinterested research that they discouraged any investigation the utilitarian value of which was not obvious."

Reymond[5] remarked in his "History of Science" that the Romans were never distinguished for any love or even interest in pure science or abstract thinking. Virtually the same conclusion was reached by Heiberg,[6] and Fowler[7] made the interesting observation that even their literature and their philosophy had a practical object. They emphasized and extolled the moral qualities necessary for the preservation of the state and the increase of its power.

In the period of the Republic, as in the early centuries of the Empire, numerous and important enterprises were undertaken. The government built roads, canals, public edifices and aqueducts. There was also much activity and increased prosperity in industry, agriculture and commerce. It might be expected that a people with a practical turn of mind would devise new and better technical methods and elaborate improved processes, but historians of the economic life of ancient Rome have shown that there was a surprising paucity of inventions. They were not only few in number, but they lacked originality and were unimportant. To meet the demand for technical devices and improved methods which arose in the rapidly expanding Roman state, they availed themselves of those originated by the Greeks, Egyp-

[1] B. Hessen, "Science at the Cross Roads," Kniga Limited, London, 1931.

[2] N. Bukharin, "Historical Materialism," translated from the third Russian edition, International Pub., N. Y., 1925.

[3] Henry E. Sigerist, "Science and Society," II, 291, 1938.

[4] George Sarton, "The History of Science and the New Humanism," Harvard University Press, Cambridge, Mass., 1937.

[5] Arnold Reymond, Transl. by Ruth Gheury de Bray, E. P. Dutton and Company, New York.

[6] J. L. Heiberg, Transl. by D. C. Macgregor, Oxford University Press, London, 1922.

[7] W. Warde Fowler, Henry Holt and Company, New York.

tians, Phoenicians and those of other nations with whom they came in contact or conquered and enslaved. They were expert in appropriating ideas as well as property that did not belong to them. They borrowed much from the Etruscans. They copied their dress as well as their architecture and learned from them some of their arts and manufactures. They were indebted to them for the art of making trumpets, candelabra, pottery and other articles. The Phoenicians and Egyptians taught them glass-blowing. From the Egyptians they also acquired the knowledge of chemical processes they used in dyeing textiles. The Greeks were their teachers not only of literature, philosophy and other cultural subjects, but they also imparted to them the knowledge of technical methods as the art of weaving, metal-working, tool-making and other information of a practical value.

Romans, like many other people, as the Greeks, thus absorbed and profited much by their contacts with foreign nations, but the results were quite different. Whereas the knowledge and ideas appropriated by the Greeks served as stimuli to intellectual progress and led to discoveries in science and new conceptions of man and the world around him, this was not the case with the Romans and is well illustrated by the condition of technology and science in different periods of their history.

In the last two centuries of the Republic industry and commerce made much progress. According to Paul-Louis[8] and Rostovzev[9] the prosperity was indeed considerable, and as might be expected would be accompanied by the introduction of a number of technological improvements. Machines driven by air and water came into use in industry, as did other technical appliances, such as the continuous screw, the pulley, water-clocks. Indeed there was a fairly long list of various labor-saving devices. Other inventions also became known, even the uses of heat and improved chemical processes. Still further progress along the same lines was made in the first two centuries of the Empire, and a more systematic use was made of the science inherited from the school of Alexandria. Notwithstanding, however, the increased application of science and the greater use of invention, no discoveries were made and no new principles were developed. Indeed the magnificent Museum of Alexandria was the greatest and last effort of the ancient world to advance science on such an extensive scale.

Not long after the Romans began to impose their authority on the Greeks science began to decay. The battle of Cynocephalae was the beginning of Roman domination of Greek lands. It was also the beginning of the retrogression of science. The decline was not rapid, however, as tradition was too strong, but science began to languish and signs of degeneration gradually made their appearance. They could be noticed even in the work of the best minds. It was quite evident in the writing of Hipparchus, who was, according to Reymond, the greatest astronomer of antiquity. Yet he rejected the hypothesis of Aristarchus, who has been aptly called the Copernicus of antiquity. It is obvious that Hipparchus did not and could not escape the influence of his environment, which is generally described as the spirit of the times, which was notoriously reactionary and unfavorable, nay even hostile at times, to the development of new ideas. It can not be denied that there was still some scientific activity, but the results were meager and, with very few exceptions, lacked originality.

Mathematics continued to make some progress. Zenodorius, Hypsicles and Diocles—the three outstanding mathematicians of the period—carried on in-

[8] Paul-Louis, "Ancient Rome at Work," Alfred A. Knopf, 1927.

[9] M. I. Rostovzev, "The Social and Economic History of the Roman Empire," Oxford Clarendon Press, 1926.

vestigations along the lines laid down by Archimedes, Apollonius and Eudoxus and made important contributions.

Though some observations were still made in Alexandria, astronomical activity mainly consisted of texts which merely contained some of the knowledge gathered by previous workers. Worse still, superstition made inroads into astronomy and was corrupted, becoming a tool of astrology. According to Heiberg, even Hipparchus helped to spread this superstition.

Additional evidence of the decline of culture and the decay of science was furnished by the degradation of mineralogy to studies of the mystical properties of metals, although scientific works on metals had previously been published.

That other sciences shared in the downward trend was shown in geography. It was no longer concerned with the purely scientific aspect, but became entirely descriptive in the hands of Polybius, Agatharchides and others. The main object of geography, according to Polybius and Strabo, was practical—to be used by rulers and generals for their special purposes. Posidonius, who is regarded as the last scientific investigator of ancient Greece, was an exception, as he gave some attention to the scientific side of geography.

Particularly marked was the retrogression of zoology. The principal work on this subject was that by Alexander of Myndus, who lived in the first century B.C. It was a mixture consisting of extracts from Aristotle to which numerous fables were added.

It is of interest to note that zoology was not given any encouragement by agriculture or medicine, which probably accounts, at least in some measure, for its low and backward state.

Medicine also had deteriorated and had fallen from the level it reached in the days of Hippocrates and the Alexandrian period when considerable scientific investigation was carried on and the medical sciences, especially anatomy and physiology, made much progress, thanks to the labors of Herophilus, Erasistratus and their followers.

In the period under consideration mainly the practical side of medicine received attention. Asclepiades, who was one of the two most eminent physicians of the time, rejected the pathology as well as the physiology of Hippocrates and developed and founded a physiology based on the philosophy of Epicurus. The other physician of this period, who was a leader in medicine, was Heraclides of Tarentum, who wrote on the action of drugs and their uses. He belonged to the Empirical School which fought shy of theory and emphasized practical experiences. Due to the use of vegetable drugs, botany received some attention, as it was studied by physicians who were also apothecaries. It is evident that medicine fell in line with the sciences in their retrogression. Science was thus allowed to decay in Greek lands that were once part of the Alexandrian Empire. Their conquest by Rome ended the period of glorious achievement of science in Alexandria and other cities, where it flourished for centuries. Neither the government nor any member of the governing class was interested in the advancement of science, and no encouragement or support was given.

After a lapse of more than a century there was a revival of Greek science which accompanied the renaissance of Greek literature in the reign of Hadrian, and when the Antonines came into power scientific activity was considerable but, as will be shown presently, it was not distinguished by great originality and was frequently highly speculative. As in the preceding period, mathematics made the most progress. The leading men constituted a group whose achievements were quite noteworthy, Diophantus being the most eminent among them. He made original contributions, especially in algebra, which he called arithmetic, and dealt

with the solution of simple as well as quadratic and cubic equations. He also invented symbols for use in algebra. Until recently the work of Diophantus had been regarded by mathematicians, Ball[10] and others, as the earliest on the subject, but it is now known that, according to Smith,[11] the Babylonians were familiar with quadratics about 2000 B.C. As a reflection of the state of science of his time it is of interest to note that the work of Diophantus failed to attract the attention of his contemporaries. Not until his works were translated in the sixteenth century into Arabic did he get recognition for his contribution to mathematics, and later when Regiomontanus translated it in the fifteenth century into Latin Pappus, who lived at Alexandria in the latter part of the third century, was the second mathematician of note in this period. His work was the starting point of the analytical geometry of Descartes. Menelaus and Nichomacus, of the first and second centuries (A.D.), respectively also attempted original research in mathematics, but all the others were mere commentators. In astronomy Claudius Ptolemy was the dominating figure. His fame and influence rested for more than a thousand years on his erroneous conception that the earth is the center of the universe, the sun moving around it. He also rejected the hypothesis of the revolution of the earth around its axis. Under the influence of his fallacious theories and inaccurate observations the world remained long in ignorance of the true explanation of the movement of the heavenly bodies. He was also responsible for spreading superstition, as he devoted considerable space in his writings to astrology, in which he was a firm believer. He did not do much better in physics. In his optics he accepted the erroneous notions of Plato. However, he performed experiments of some importance on refraction and made observations on reflection with mirrors. Ptolemy imposed a considerable number of fallacies on his own and succeeding generations which persisted for more than a thousand years. And all this was accomplished in complete disregard of the great Aristarchus of Samos, whose remarkable discoveries and almost modern ideas antedated the writings of Ptolemy by nearly four centuries, which strongly emphasizes the decline of science in the Roman Empire. Hero of Alexandria may be included in this period, as he probably lived in the first or second century A.D. His writings were of a purely practical character. His work on mathematics was based largely on Euclid and Archimedes and did not contain anything original. Its main object was to aid in surveying. His principal contributions were in engineering and consisted of the invention of a leveling instrument, with books on vaults, throwing machines and works on mechanics which were derived from Archimedes. His books, especially those on pneumatics, show many defects indicating carelessness and little regard for experiment. Among the ideas he appropriated from others may also be mentioned the automatic theater, which originated with Philo. It should be added that his works have been of much value in throwing light on the state of science of his time and furnishing the best account of Greek mechanics.

Medicine in the Imperial period shared in the general decline of culture. The exhaustive account of Neuberger[12] shows that it was in a deplorable condition in the time of Galen. Owing to the lack of able thinkers and leaders capable of developing scientific methods, speculation dominated medical thought and whatever medical research there was at

[10] W. W. R. Ball, "A Short History of Mathematics," Macmillan and Company, London, 1901.

[11] David Eugene Smith, "Scripta Mathematica," IV, 111, 1936.

[12] M. Neuberger, "History of Medicine," transl. by Playfair, Oxford, 1910.

that time. The state of medical education was at a very low level. The medical sciences were taught in general educational institutions, and instruction consisted of didactic exercises only. Even anatomy was learned merely from books. There was no state supervision of medical education nor did the Roman rulers take any interest in it, until Alexander Severus, who was the first to appoint salaried teachers in medicine and to provide special lecture rooms. In the absence of control by the state charlatanry flourished, and Rome was full of quacks. Superstition in medicine was wide-spread in the Imperial era, and even the medical profession catered to the ignorant public by approving of various magical and superstitious rites as therapeutic measures without drawing much protest from the cultured class, which also believed in them. However, it should be noted that some of the Emperors of the first and second centuries did make an attempt to improve conditions in the practice of medicine. All forms of superstition and the beneficial effects of miracles had such a hold on the mind of the public that, according to Neuberger, Pausanias and Suetonius fell victims to it and even Pliny was not completely free from superstition.

Thanks to tradition, however, the Roman Empire could boast of a few medical men who, for their day, may be regarded as men of science and did make some contributions of value, as Themiso, the founder of the so-called Methodist School in Medicine, who lived in the first century A.D. Another member of this school was Soranus of Ephesus, who flourished in the second century A.D. He wrote on every branch of medicine and left also a creditable work on obstetrics and how to care for the new-born child.

Archigenes was the best representative of the Pneumatist School, which made careful studies of diet and investigated the effects of wine and mineral water. He also wrote on the effects of medicines, which we would now call pharmacology.

The most important figure of this period was Galen, who died in 200 A.D. His ideas on clinical medicine, pathology, the effects of drugs and on physiology prevailed for about 1,500 years. In fact, they dominated physiology and medicine. He dissected animals of all kinds, especially the anthropoids, and carried on experiments on live animals. His writings were voluminous and dealt with many branches of medicine and surgery. Therapeutics also received special attention. He has been regarded as the founder of experimental physiology and made valuable contributions, the most important being the demonstration that the arterial pulse is due to the action of the heart. He made observations on the movements of the heart and studied the movements of the blood, but failed to discover the circulation, though he came very close to it. He also carried out studies on the physiology of respiration and the functions of the nervous system, making numerous experiments on animals for this purpose. Notwithstanding his devotion to the experimental method in physiology, his work in anatomy and the clinical observations he made he did not escape the influence of his environment. *A priori* conceptions found a prominent place in his scientific endeavors and, of course, vitiated his results. He was given much to speculation and he greatly stressed design in nature. Theory was emphasized rather than, and at the expense of, unbiased observation. The induction and empirical observation so characteristic of Hippocrates and his followers received a subordinate place in Galen's scientific work, though he was not opposed to the teachings of Hippocrates. In some respects Galen even followed the great master and tried to restore Hippocrates's methods and ideas, but all his efforts were unsuccessful. The conditions and the spirit of the times were unfavorable and were incompatible with the freedom of thought and originality of Hippocrates and of his day.

The renaissance of the second century

A.D. in Rome was but an artificial imitation of ancient culture. Science and art lacked originality. Medicine did not and could not rise above the prevailing level of culture and assume an attitude of mind different from that which was characteristic of the time. If under Roman domination the Greeks, notwithstanding their tradition of the golden age of science, either lost the spirit of their ancestors or lacked the power or both to continue in their path what, may be asked, was the attitude of the Romans themselves toward science? The ruling class being Roman and in possession of wealth and tremendous power, what interest did they show in science? The answer was partly indicated above. It might be added that the Roman, whatever his class, had even less regard for science than the Greek idealist who followed in the footsteps of Plato. While Plato denounced experiment as a base art he at least regarded mathematics as a sublime study worthy of the attention of philosophers, which he exemplified by his own devotion to the subject. But not so the Romans. To quote Heiberg again, "they had always in their hearts that mixture of suspicion and contempt for pure science which is still the hall-mark of the half-educated." An illustration of the lack of esteem, even of the most cultured, for pure science were the utterances of Cicero. He spoke with approval of the Roman dislike of mathematics, except as it serves practical ends. To what extent they ignored the interests of science is well shown when the records of their scientific activity are examined, which were very scanty. Though much surveying and construction were carried on in the Roman Empire the mathematics used was translated from Greek texts and was reduced to mere rules that could be readily applied so that knowledge of theory and understanding of principle were not necessary. When surveying beyond the simplest type was needed, Greeks had to be employed, showing how little the Romans knew even of applied science. That no work of merit on mathematics was produced by Romans is well known. The same was true of astronomy. In the natural sciences Pliny was the outstanding figure, but his work was mere compilation and much of it was worthless.

Medicine did not fare much better. Cato advocated the use of panaceas and had no use for physicians. The only works of value were translations from Greek originals, as those by Celsius and later by Caelius Aurelianus, who rendered into Latin the works of Soranus.

Descriptive geography and ethnology received some attention at the hands of a few writers and statesmen. Cato, Sallust and Caesar made some contributions in these branches, but of scientific geography the Romans had little or no idea. They were centuries behind the ancient Greeks in this respect, as shown by the writings of Tacitus—in which it appeared that he did not know that the earth is round. The above account gives a good picture of the state of science in the Roman Empire.

As might be expected, superstition flourished under such circumstances. Astrology was highly regarded and was considered a science. It was popular with the cultured and even with men of letters.

Scientific work of any consequence among the Romans, as will have been noticed, was Greek in origin. The most important scientists who worked in ancient Rome were Greeks and wrote in their own language, while works of science in Latin were translations from Greek.

It has been maintained by a number of writers that science is due to curiosity and that its development is also stimulated by contacts, imitation and other factors. Merton[13] attaches much importance to the effects of what he terms

[13] R. K. Merton, SCIENTIFIC MONTHLY, p. 165, Feb., 1937.

interrelation as a catalyzer of scientific thought. Commerce and industry are stressed by others as conditions favorable or even necessary for the progress of science. The cultural level and spirit of the age are assigned by a not small number of historians and philosophers of science as the determining factors in the growth of science. Certainly some of the above conditions existed in ancient Rome.

The progress of science in Greece was associated with the development of trade and industry, but their expansion in Rome in the last two centuries B.C., under the Republic and during the following two centuries in the Empire, as we have seen failed to bring about a significant advance in scientific knowledge. Though there was some scientific activity the results were immeasurably inferior to those of Athens and Ionia centuries before. It was much below the level of Magna Grecia and Alexandria.

To explain the state of science in lands under Roman rule the history of economic, political and social changes must be taken into consideration. As in the case of other ancient peoples, agriculture and raising of cattle formed the chief means of their subsistence in their early history. They were then peace-loving and industrious farmers, but driven by necessity they later became aggressive and warlike. The need of more land became urgent early in their history, as the soil was poor and could not support them adequately nor provide them with the necessary materials for the manufacture of clothes and other necessities. They therefore attacked their neighbors and deprived them of their fields and their cattle. Due to their backwardness and the primitive methods of agriculture and since Campania, Etruria and Lucania were not able to supply enough food, the Romans also made war on Sicily, Africa and Egypt to obtain cereals which these lands raised in abundance. Conflicts multiplied, became prolonged and bloody. Later war was incessant and the effects it produced brought about profound changes in the economic and social history of ancient Rome, affecting the character as well as the culture of the Romans. The concentration of land in fewer hands which began in the fifth and fourth centuries B.C. steadily increased and was greatly accelerated by conquests. The nobility and the plutocracy invaded the public lands, as was especially the case at the end of the Samnite wars, and also appropriated (during the earlier conquests) the land assigned to the plebeians in the conquered territories. The great wars during the period of the Republic contributed in other ways towards the growth of large estates known as latifundia, which reached their full development in the first century before the Christian Era and continued to expand until they reached the size of veritable principalities by the end of the first century A.D. The enormous number of captives sold into slavery provided the latifundia with an abundant supply of cheap labor which enriched the very large owner and ruined the small farmer, thus eliminating the middle class from agriculture.

But conquest furnished yet easier ways of accumulation. The victorious generals returned with thousands of pounds of gold and silver, most of which they did not hand over to the government. This influx of wealth also served to enrich the commercial classes and in the days of Cicero made many millionaires with very large incomes. The huge fortunes which were thus acquired called for little or no effort and an idle parasitic class thus developed with a passion for extravagance and luxurious living which was truly pathological. Commerce and industry, as was stated above, had greatly expanded during this period, but the prosperity was largely due to the great demand for luxuries. With abundant money in circulation prices were, therefore, very high and profits enormous,

which led to speculation rather than to the development of constructive enterprise and increased production. With slave labor in abundance there was naturally no need of new and improved methods to make enterprise profitable. Only such appliances and processes were introduced which were absolutely necessary, as when the tasks could not be satisfactorily, or at all, performed by human hands. Those already in existence and inherited from the Greeks and others of previous ages sufficed for the very limited needs. Besides, a class bent largely on spending and ease could not be expected to, and in fact did not, possess the mental attitude which leads to invention and supports or encourages discovery. Moreover, the outlook on life under these conditions was not the same as in modern times, when those who control production and exchange invest their profits to expand their enterprise and improve methods to increase profits.

As might be expected, the methods of agriculture were scarcely, if at all, improved with thousands of slaves on a single latifundium. The Romans of the period of the Republic were centuries behind the Greeks and Egyptians in this respect. Their agricultural implements were made of bronze and were usually manufactured on the premises, and scythes were not even sharpened with stones as late as the first century B.C.

The backward condition of technology was not the only factor underlying the decadence and the retardation of scientific development. The wars, foreign and internal, absorbed the energy and destroyed large masses of men. The classes from which scientists and inventors are recruited suffered heavy losses and those who survived could not but be affected by the prevailing outlook of their class upon life with abnormal tastes and unhealthy extravagant mode of living, which alone unfits body and mind for any exertion, not to speak of productive scholarship.

Fowler pointed out that the very large number of men killed in the wars carried on during this period greatly deteriorated family life, divorce was common and the women became neurotic. The effect on their progeny must have been unfavorable and undoubtedly contributed to the mental, moral and physical deterioration of the Romans. We have, therefore, a number of factors all of which combined must be detrimental to science as indeed to every form of intellectual activity. Nor can it be too strongly emphasized that the freedom of the individual, not only of the slave, but even of the citizen, had always been restricted in the Roman world. The individual was at first subordinated to the welfare of the primitive family or clan and later to the interests of the state when he was tied to the army and thus deprived of freedom of action. The possibility of self-expression and development of his individuality—the very condition so essential for scientific progress and which contributes so much to the advancement of science and also philosophy were absent in the Roman world from its early history.

As was stated above, science during the period of the Empire too had not met with much encouragement, and only exceptionally did the Greeks and hardly ever the Romans themselves make some contribution. The reason must again be sought in the state of society. Economic and social conditions in this period had undergone a considerable, though gradual, change from that which prevailed in the latter centuries of the Republic. Many improvements were introduced not only in manufacture but even in agriculture. On the latifundia, according to Rostovzev, agriculture was carried on along capitalistic and scientific lines, displacing the primitive peasant economy. Pliny the elder is authority for the statement that the works of Varro, Cato and Columella were used in their efforts to improve agricultural methods. This is

particularly interesting in view of the fact that just at this time slavery began to decline, thus indicating its inhibitory effect on the progress of technology and the advancement of science which sometimes results from it, especially when science is in its formative stage. However, notwithstanding these gains, economic and technological, science in this period failed to profit substantially. Some activity there was, as shown by the work of a few men, but in the main, as pointed out above, science continued to show deterioration. Analysis of the state of society reveals that some of the factors believed to be inimical to the development of science during the latter centuries of the Republic persisted. The mode of living and the outlook of the ruling class had not changed. Extravagance and luxury were still characteristics of the wealthy and also of the high officials. Many forms of self-indulgence producing enervation and an abnormal state of mind were quite common in the higher social strata now as before. But above all due consideration should be given to the following factors which are of particular importance, as they help to explain the state of science under the Empire.

Though industry and commerce had greatly expanded, agriculture still retained its supremacy in economic life and the latifundia continued to increase in number and also in size. Indeed half of Africa was in the hands of six owners about the year 100 A.D. The effect of the Pax Romana and the suppression of piracy are important in this connection. No longer were the markets flooded with tens of thousands of captives. But the tremendous power and influence which the owners of the vast princely estates exerted on politics and in society would necessarily lead to some governmental action to remedy the shortage of cheap labor and prevent the impending ruin of the great estates. The government therefore established a new institution, the coloni, who were the precursors of the serfs of the middle ages and not much different from them. Under the new system of labor the individual was, by law, bound to the land. Neither he nor his family could be sold like chattel, but his personal freedom was nevertheless nil. The social effect was important, as this form of bondage made its inroads into the free citizenry and the impoverished middle class, thus abolishing the liberty of a class that was once free.

Nor was this the only change. A number of new factors had developed which profoundly and sometimes quite rapidly modified society. The decline of slavery, civil wars, barbarian invasion and, not the least important, the insecurity of existence which these caused, produced economic ruin. This was materially aggravated by the exactions of the treasury, which, as in our day, was so burdensome that it checked production and threatened the very existence of the state. All these led to the establishment of state factories, with rigid control of production and exchange. Associations were created by the government which were charged with the duty of production and distribution. These corporations abolished initiative and, in ways innumerable, hampered and destroyed the freedom and initiative of the individual. Nor were these restrictions limited to the laborer. The possessors of wealth were also affected. It was a totalitarian state where all were subjected to its authority. As in fascist states to-day, freedom of the individual was extinct for the citizen, rich or poor. Science could not prosper under these conditions, as it received no recognition and little or no opportunity to develop, material and moral support were wanting. The attitude of mind induced in such an atmosphere, being wholly antagonistic to innovation, development of curiosity and creativeness, inevitably led to intellectual stagnation and hence to the decline of science.

The close relationship which has been shown to exist between the development

of science and socio-economic conditions naturally prompts the question why science made such strides in some Greek states. What was there in Ionia, Athens and Alexandria and Magna Grecia that made science possible?

Greek, like Roman, society was based on slavery, and agriculture was the main occupation of the Greeks. Commerce and industry were highly developed in the Greek state, but, as we have shown, these also reached respectable proportions in Ancient Rome. Class conflicts resulting in civil war and foreign wars also were common to both. Analysis shows, however, that notwithstanding their similarities the societies of Greece and Rome differed radically in many respects. In Ionia, Attica and the islands of Greece there were no large estates or latifundia. According to Glotz[14] in the fourth century B.C. in Attica an estate of forty-five acres was not considered small, while those who owned about sixty-four acres were counted among the rich landlords. This was also the case in Asia Minor and the islands. The love and respect the Greeks had for work is shown in many ways. All the landlords, even the rich, worked the land with their own hands, in striking contrast to the Roman owners of the latifundia. Slaves were, of course, employed, but mainly as domestics. Greek farmers used much skill and ingenuity, as they had to in order to improve the land, for the soil was very poor, which explains why slaves were employed so little in agriculture. As Xenophon said, the Greek farmer had to keep his eyes open and ask questions. In other words, he was compelled by the nature of his existence to observe and think, which thus made the Greeks such keen observers and alert mentally. Attica was poor in raw materials for use in manufacture and had few agricultural products. Hence trade was important and, the roads being bad, maritime commerce was necessarily developed and shipping made tremendous progress from the fifth century B.C. on. Hence Athens became supreme in commerce, and industry was greatly stimulated.

In the fourth and fifth centuries B.C. industry became so important economically and was so highly esteemed by the citizen, even by some philosophers, like Socrates, that craftsmen acquired political power. There were masons, shoemakers and other workers in the Athenian Assembly. Though the nobility and philosophers, like Plato and Aristotle, had contempt for every form of manual labor, citizens and even their daughters engaged in industry and trade. It was a disgrace to do nothing to escape poverty, said Pericles. Craftsmen, as artists, were honored, and commercial careers were not despised, even by intellectuals who preferred the liberal professions. In this connection it is worthy of mention that the sons of craftsmen and merchants entered the professions and took up intellectual and literary occupations. Socrates was the son of a stone mason. The father of Sophocles was a blacksmith, and Demosthenes was the son of an armorer. Though slaves were largely or in some cases almost entirely employed in industry much technical progress was made. Also slaves in Attica received protection against abuse and were considered human beings in the eyes of the government. Slaves were not as cheap as later in Rome, which may account for the progress of technology and the better treatment. That society in Athens and other progressive cities of Greece was different from that in Rome and the territories it ruled is shown by their different modes of living and hence their outlook on life. The Greek citizen of Attica, as in Ionia, was abstemious, frugal, worked in the fields, shops and at other tasks too numerous to mention. In addition he sailed the seas in search of trade or to explore and settle in distant countries where better

[14] Gustave Glotz, "Ancient Greece at Work," Alfred A. Knopf, New York, 1926.

opportunities awaited him. His mind was thus sharpened, his ambition aroused, and his imagination stimulated and his outlook broadened. This spirit of adventure naturally affected also the superior mind, but the reaction was different and manifested itself in the quest for new knowledge and led to the development of new ideas.

Science and philosophy, inseparable from it in that age, became the chief occupation, and the only one in some cases, for a small class, while some individuals divided their time between learning and business. However, commerce and industry do not always lead to intellectual development and to the progress of science. Corinth, according to Jardé,[15] was a great commercial and cosmopolitan city. It was known for its commerce and industry far and wide. It had built many ships for its trade with distant countries and had a powerful navy. Nowhere was manual labor more or even as much respected and honored. Wealth in land was unknown and there were no great landlords there. This, as will be seen, is a great advantage for science. Yet Corinth produced no science, though it was sufficiently advanced to use machines in some of its enterprises, especially for transport. The reason can only be guessed. The commercial spirit was so predominant that, like war among Romans, it probably absorbed the energy of the ruling and wealthier classes who had leisure. And it is also worth mentioning, Corinth was a great pleasure-loving city. As the upper class could not have been large, it is within the bounds of possibility that the pursuit of wealth and pleasure also affected unfavorably the still smaller group of the more gifted among them. They probably could not emancipate themselves from the prevailing attitude of mind of the ruling class. Hence, as Clark[16] maintained, it is not a single factor which may be held exclusively responsible for the state of science. While a commercial and industrial nation may and often has produced men of science, this is not always and not necessarily the case. However, there is little doubt that some forms of society are unquestionably unfavorable, if not always antagonistic, to the progress of science. A country predominantly agricultural, with a rich and powerful landed aristocracy, has always been static in character and thus hostile to new ideas. This was the case in ancient Rome, in Sparta, Thessaly and other Greek states which were ruled by landed nobility. The feudal barons of the middle ages were no better. As Kofoid[17] pointed out in a recent article, science worthy of the name scarcely existed in the South before slavery was abolished. Society then determines the growth or the decline of science. It was no accident that the rise of Greek science followed the disintegration of primitive communism and the patriarchal family. Individualism and private property came into existence and permitted the unfolding of individuality. Likewise in the Renaissance science once more came to life and was destined to be raised to an infinitely higher level. The dissolution of the feudal system and the rise of the city bourgeoisie explain the age of discovery and the rebirth of science.

This study thus is in harmony with the conclusions of Levy[18], Hogben[19] and others, according to whom science has its roots in society. However, when some writers maintain that the economic factor alone accounts for existence and progress of science, this is an over-simplification and leads to erroneous conclusions. A number of conditions seem to cooperate in producing effects on science, beneficial or otherwise.

[15] A. Jardé, "The Formation of the Greek People," Alfred A. Knopf, New York, 1926.

[16] G. N. Clark, "Science and Social Welfare in the Age of Newton," Oxford Clarendon Press, 1937.

[17] Chas. A. Kofoid, *Science*, 88: 109, 1938.

[18] H. Levy, "Universe of Science," The Century Company, New York, 1933.

[19] Lancelot Hogben, *Science and Society*, 1: 137, 1937.

AGE AND HIGHWAY ACCIDENTS

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IT will be the purpose of this paper to study the effect of age on highway accidents in the light of available facts. Since little is known or done about elderly users of the highway, special attention will be given to the effect of the aging process on driving.

More than a quarter of the population in the United States is over 40 years of age, and this proportion is steadily increasing. On the other hand, safety education is only now being seriously introduced into our public school system. Accordingly it will be years before present-day safety-minded children will replace our less safety-minded adults and improve the accident situation. In the meantime, our unselected drivers who were trained on 30-mile per hour cars will have to be retrained to drive their improved vehicles safely at the higher rates of speed prevailing on our highways.

All but five states license drivers. Only about half of them, however, require a road test examination. But even in our progressive states the selective measures to license drivers have had little effect on our adult driving population. The simple reason is that most state license laws were put into effect recently (Fig. 1) and all persons then operating motor vehicles were exempted from examination. Hence a considerable portion of our adult driver population has never had its ability or right to drive questioned.

Another fact commonly ignored is that many of our elderly motorists learned to drive relatively late in life when their habits were rather inflexible. Elderly

First Issued Between 1900 and 1914
First Issued Between 1920 and 1929
First Issued Between 1930 and 1938
No Drivers' Licenses Required

FIG. 1. DRIVERS' LICENSES—DATES OF ISSUANCE.

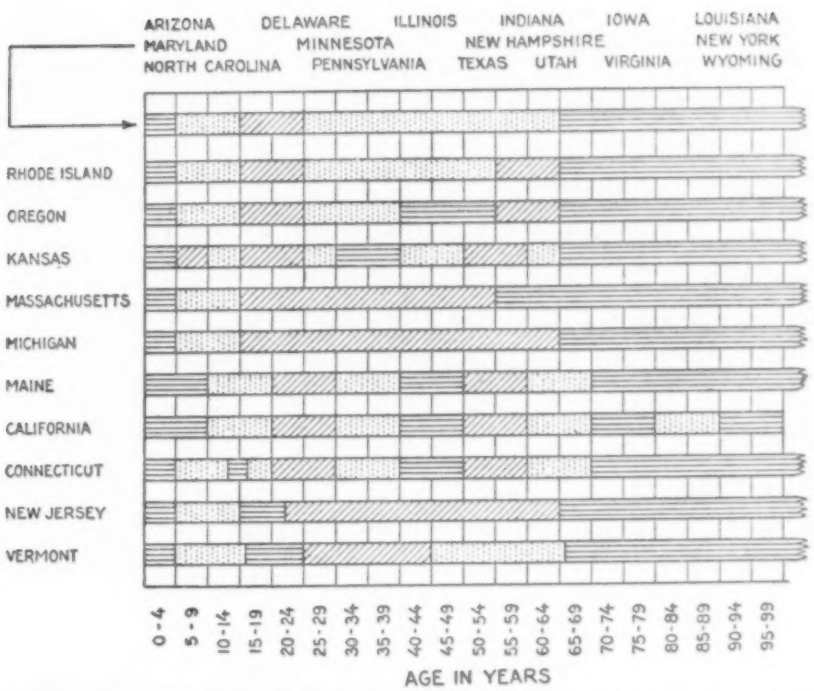


FIG. 2. GRAPHIC COMPARISON OF STATISTICAL AGE GROUPINGS OF ACCIDENT VICTIMS, USED BY 26 STATES (EACH DIVISION OF A BAR REPRESENTS A STATISTICAL GROUP).*

persons learn more slowly, and when they have attained a minimum standard of skill are more apt to be satisfied than youngsters. Many have never pushed on to the higher level of skill reached by present-day young people, so many of whom receive rigorous training followed by an examination. Add to this the fact that elderly persons learned to drive with old, noisy, slow cars with high seats and correspondingly easy visibility on uncongested highways, and one sees a reason for present-day maladjustments among our "old timers."

But in spite of its obvious importance there is a dearth of dependable facts about the relationship between age and motor vehicle fatalities. The reason is fairly easy to find. State motor vehicle departments whose records represent the only reliable source of facts about drivers have only in isolated cases become interested in age as a factor in accidents.

The statistical summaries of most motor vehicle departments contain age groupings that are too gross. The majority of states which do make statistical analyses of accidents divide the accident victims into three age groups, namely: (1) 15–24; (2) 25–64; (3) 65–over. There are, however, a few other groupings used (see Fig. 2). The point at issue is not which classification is the best. Any simple decade grouping would be satisfactory, but some uniform classification should be adopted throughout the country so that age statistics in different states could be compared.

The motor vehicle statistics now available do not indicate whether the individuals killed or injured are operators, passengers or pedestrians. Since the proportion of operators, passengers and

* From "Motor Vehicle Traffic Conditions in the United States," Part 3, U. S. Government Printing Office, Washington, D. C., 1938.

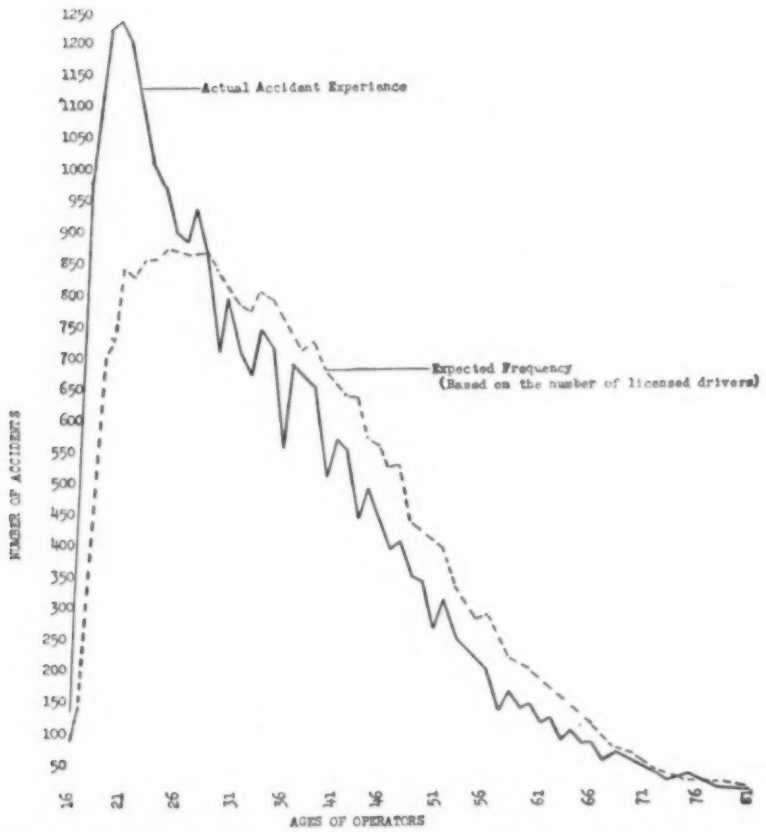


FIG. 3. COMPARISON OF ACTUAL TRAFFIC ACCIDENT EXPERIENCES, WITH EXPECTED ACCIDENT FREQUENCY.†

pedestrians on our highways varies from time to time, it is highly desirable to analyze the three groups separately.

It is particularly important to separate them in making any study of the influence of age, since we already know that accidents occur more frequently to drivers when young and to pedestrians who are old. Unless fatal accident figures are separated into operators and pedestrians it will be impossible to learn anything about the age problem.

Another weakness of present-day age statistics is that in only one state, Connecticut, has an age census of drivers been made over a period of years. In Connecticut an age census has been available since 1923. Up to 1931 it was divided into 10-year age periods. Since 1931 it has been broken down into 1-year age groups.

The Connecticut studies show that the average age of all drivers is 37, whereas the average age of all newly licensed drivers is 28. The average age of Connecticut drivers is increasing at the rate of one year with the passage of every four years. By 1950 the average age of Connecticut drivers should be about 40.

As can be seen by the accompanying graph (Fig. 3) the largest group of licensed drivers falls into the 20–29 year group. It is also noticeable that the drivers in the 20–29 age group have pro-

† From a study made in Connecticut Motor Vehicle Department by WPA project 3231.

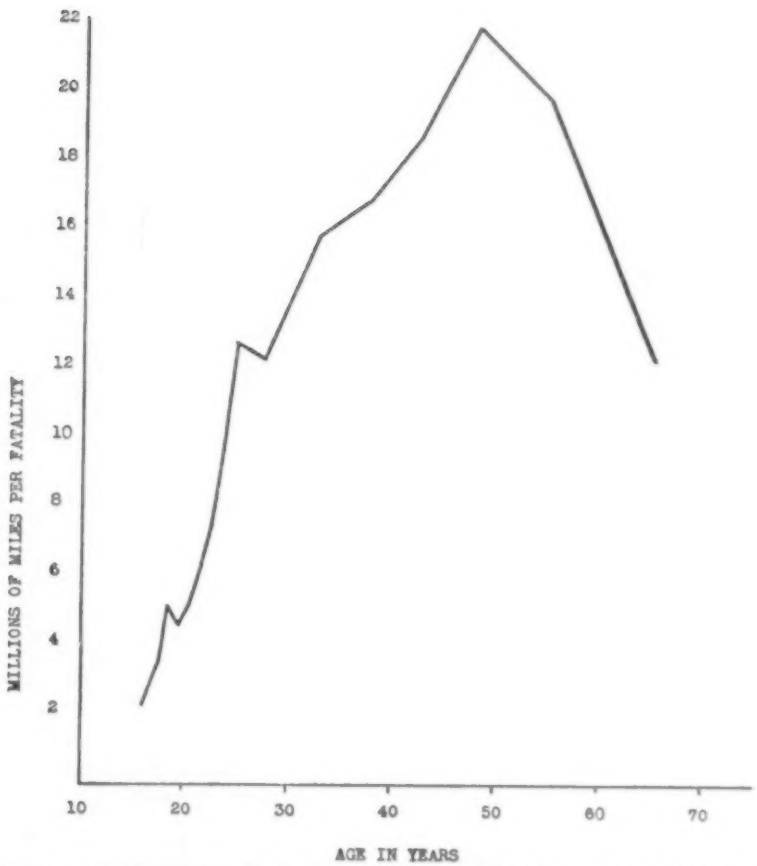


FIG. 4. MILEAGE DRIVEN PER FATALITY FOR DRIVERS OF DIFFERENT AGE GROUPS.‡

portionately more accidents than drivers in other age groups. Approximately the same number of drivers are in the 60-year group as there are in the 17-year-old group.

Taken by itself Fig. 3 would seem to indicate that our chief trouble is with the youthful offender and that the aged driver is a relatively unimportant factor. But before laying too much emphasis on the follies of youth we should take into account the exposure in terms of yearly mileage, the speed of driving, the age factor among pedestrians killed, the prevalence of intoxication and the different types of accidents.

‡ From safety and traffic engineering department, American Automobile Association.

Fig. 4 is taken from a study made by Burton W. Marsh, director of the Safety and Traffic Engineering Department, American Automobile Association. It reveals that young drivers between 16 and 20 years of age drove less than one fifth as far per fatal accident as do drivers between 45 and 50 years of age. Furthermore, with increasing age up to 48 there is an increase in the distance driven per fatal accident (in which drivers are involved). But beyond 48 there is a rapid decline in the accident rate in terms of exposure until by the age of 65 the driver is as unsafe as the 25-year-old one. According to these results both *the youthful driver in his 'teens and twenties and the elderly driver in the fifties and*

sixties are less safe than the adult in his thirties and forties. There are fewer drivers on the road beyond fifty, and although they drive less distance their accident rate starts to increase again.

Fig. 5 was compiled from the replies of over 1,000 drivers of different ages when questioned about their preferred open road speed. Since there was no compulsion to answering the question and since the person's name was not taken, it may be assumed that the answers were about as truthful as could be obtained. The curve shows that young people drive at higher average speeds. Possibly they are also more inclined to minimize their reported driving speed than their elders. At any rate, we have evidence that young people in their twenties not only drive farther than older persons but also faster. Were the fifty- and sixty-year-old drivers to drive as fast as the younger people they would undoubtedly have an even higher accident rate. Persons beyond their forties can not expect to continue to drive at the same rate as they did in their younger days. For in spite of driving at slower speeds the accident rate goes up beyond fifty.

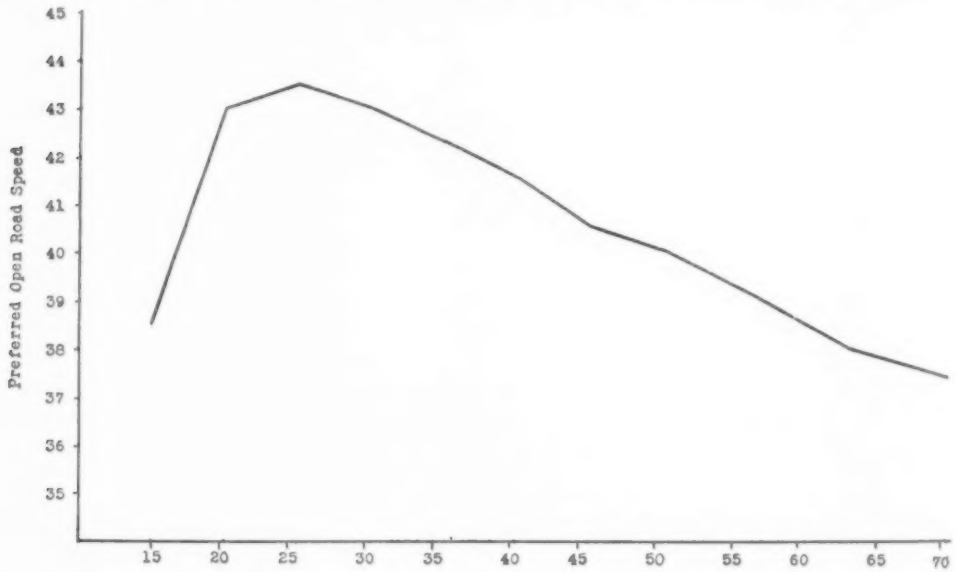


FIG. 5. PREFERRED OPEN ROAD SPEED AT DIFFERENT AGES.

Fig. 6 shows that the majority of fatal accidents involve operators and passengers who are in their twenties. Conversely, the majority of fatalities among adult pedestrians occurs in the fifties and sixties. The aging process takes its toll of the old pedestrian to a greater extent than the young one for a number of different reasons. Elderly people are not as spry, they can not see and hear as well, and they succumb more readily to an injury. The older person as a pedestrian has even more need to be trained in safety than the aged motorist. A consideration of the death rate at the different ages as in Table 1 shows that the pedestrian in the fifties and sixties is the most dangerous risk. Since all motorists are also pedestrians, safety education among old motorists ought to help in the problem of training old persons to cross the highways safely.

Table 2 shows the incidence of alcohol-

TABLE 1

RELATIONSHIP BETWEEN HAZARD AND AGES OF PEDESTRIANS

Age	Number killed	Per cent. ped. of total killed	No. of years in age group	No. ped. killed for each year included	Av. no. of survivors of 100 born	Ratio of ped. killed to survivors
2 to 5 years incl. ..	13	93	4	3.2	83	39
6 to 9 " " ..	13	77	4	3.2	81	39
10 to 20 " " ..	7	25	11	0.6	79	8
21 to 30 " " ..	3	12	10	0.3	75	4
31 to 40 " " ..	22	56	10	2.2	69	32
41 to 50 " " ..	16	76	10	1.6	62	26
51 to 60 " " ..	30	88	10	3.0	53	57
61 to 70 " " ..	18	95	10	1.8	40	45
71 to 81 " " ..	10	100	11	0.9	23	39

TABLE 2

INCIDENCE OF ALCOHOLISM AMONG DRIVERS INVOLVED IN ACCIDENTS IN CONNECTICUT BY AGE OF DRIVER, 1936

Age	Alcoholic operators causing accidents*	All operators involved in accidents†	Per cent. alcoholic	Relative incidence all ages = 100
Under 20 ...	21	1,970	1.07	38
20 to 29	242	8,940	2.71	97
30 to 39	192	7,804	2.46	88
40 to 49	143	4,602	3.11	111
50 to 59	48	2,223	2.16	77
60 to 69	19	875	2.17	77
70 or more ..	3	225	1.33	47
Not stated ..	122	1,615		
All ages	790	28,254	2.80	100

* Number of alcoholic operators from Connecticut Department of Motor Vehicles Bulletin "If You Drink, Don't Drive. If You Drive, Don't Drink."

† Number of all drivers involved in accidents from "Statistical Summary of Traffic Accidents Caused in Connecticut—Calendar Year 1936."

ism among drivers involved in accidents in Connecticut. According to these results the driver in his forties is most frequently intoxicated in spite of the fact that we learned in Fig. 4 that this age driver is also the safest in terms of distance driven. There is, however, not much difference in the incidence of alcohol between the man in his forties and the man in his twenties and thirties. The reason more drunken drivers in their forties are detected is that more persons drink in their forties than at any other age. Since drivers beyond their forties become more prone to accident it behooves them especially to refrain from mixing drinking with driving.

The story of deterioration among elderly drivers can be told more graphically by charts than by words. Figs. 7 and 8 show (1) the gradual but steady decline of ability in steering coordination, (2) a slowing down in brake reaction, (3) an increased sensitivity to glare and (4) a larger number of rejections on road tests. Although this decline of ability is important and should be recognized and allowed for by persons as they grow older, the rate of decline has too often been exaggerated. The assets of the older persons, such as improved judgment, better emotional control and coolness in the face of emergencies, usually more than offset the slight loss of sensory capacity and motor control. As an example of the assets of the mature adult is his improved performance on our vigilance apparatus shown in Fig. 9. In this test the driver has first to respond to simple situations, and then to respond to a combination of situations at once. The degree of his improvement when performing under complex conditions as compared to his ability to perform in a simple situation is the measure of his adaptability and vigilance. In performance of this sort older experienced drivers invariably rank higher than young ones.

I shall now attempt to summarize weaknesses and strengths of youthful, middle-aged and old drivers and pedestrians. If this paper has devoted more of its attention to the elderly person it is because he is too often neglected as a source of accidents. Since the average age of both drivers and pedestrians is increasing we must perforce give more heed to them than heretofore.

Youthful operators unquestionably have the greatest accident incidence. The proportion of operators killed represents by far the largest of any age group. They drive more rapidly and travel

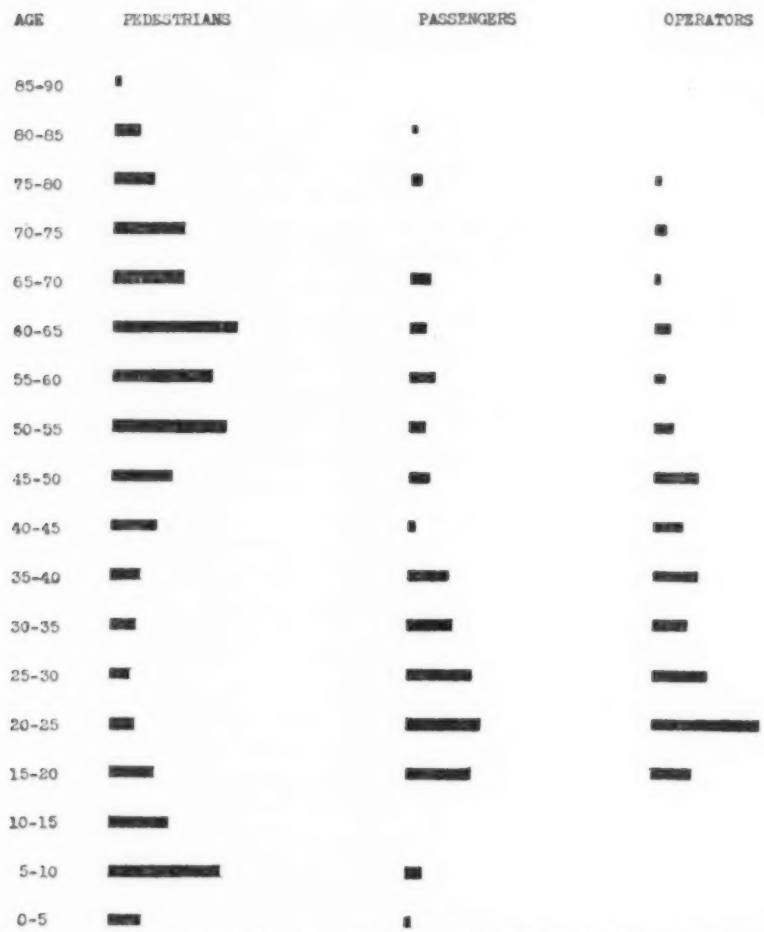


FIG. 6. AGE AND SEX OF PERSONS KILLED IN CONNECTICUT MOTOR VEHICLE ACCIDENTS DURING 1931.§

farther than older drivers. Having less experience and less responsibilities (there are fewer car owners and less married men in the younger age group) they undoubtedly drive with less restraint and are more interested in getting places in a hurry. They have less insight into their own faults and into the possible defects of their cars. Since they are continually exploring new and unfamiliar roads they are less well acquainted with the dangers that may confront them on the highway. Their ability to respond to complex situations and emergencies is not as good as it will be in later years. The chief redeeming virtue of young people is that they have keener eyes, more sensitive ears, quicker reactions and a better coordination.

All these abilities serve young persons in good stead and make them the safest pedestrians on the highway. This is fortunate indeed, since if they did not have these assets they would undoubtedly have a higher accident ratio as drivers, considering their high rate of travel and great yearly mileage and their habit of one-arm driving.

What is the solution as regards the

§ From eighth study of motor vehicle accidents in the State of Connecticut by Richard S. Kirby, 1932.

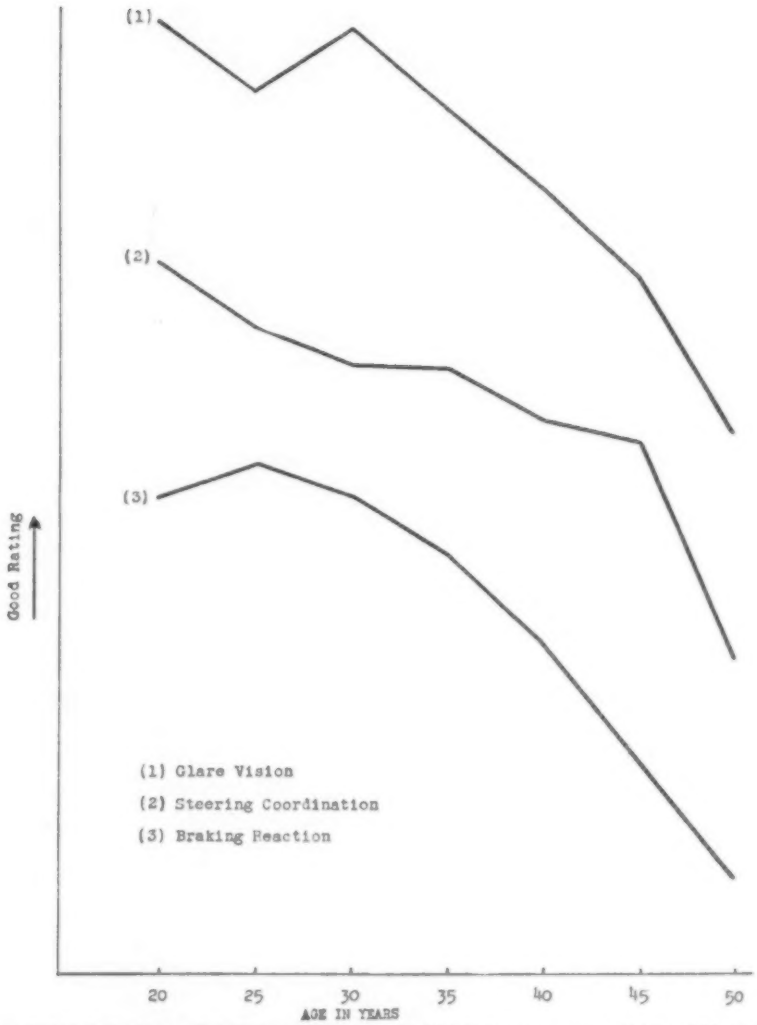


FIG. 7. GENERAL DECREASE OF ABILITY WITH AGE IN (1) SENSITIVITY TO GLARE, (2) STEERING OR EYE-HAND COORDINATION, AND (3) BRAKING REACTION TIME.

young driver? Training by a skilled instructor before being allowed to take a license examination; a comprehensive license examination designed to test the driver's facility in handling a car under various road conditions; a traffic law test; various sensory and coordination tests aimed more at giving him insight into his weaknesses than to disqualify him. As an example of the need of the latter type of test may I mention the following case: A trained driving instructor worked for weeks trying to prepare a youngster for his examination. He, by chance, brought the boy into a driver clinic and discovered that his depth perception was very poor. After being fitted with a proper pair of glasses, the boy took and passed his examination after only two more lessons.

Middle-aged drivers, having more experience and more responsibilities, have a better accident rate in spite of the fact that they drive almost as fast and as far as the younger group. An outstanding

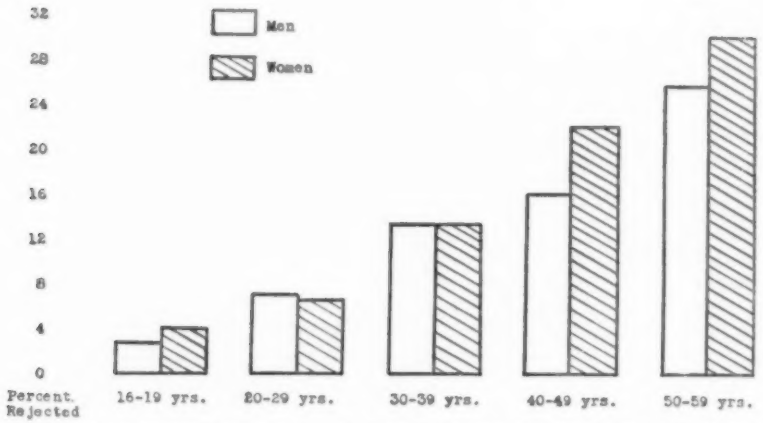


FIG. 8. PER CENT. OF APPLICANTS REJECTED ON ROAD TEST—ACCORDING TO VARIOUS AGE GROUPINGS.¶

paradox of middle-aged drivers is that during the period of least accidents (45–50 years) we find the greatest incidence of alcoholic drivers.

How can we improve the middle-aged drivers? By educating them to avoid mixing drink and driving. By re-examining in a driver clinic, such as is employed in the Wichita Police Department and the California Motor Vehicle Department, all drivers who have a serious moving violation or accident.[1]

The outstanding characteristic of the elderly driver is a decrease in sensory

¶ From a study made in 1932 by the Connecticut Motor Vehicle Department.

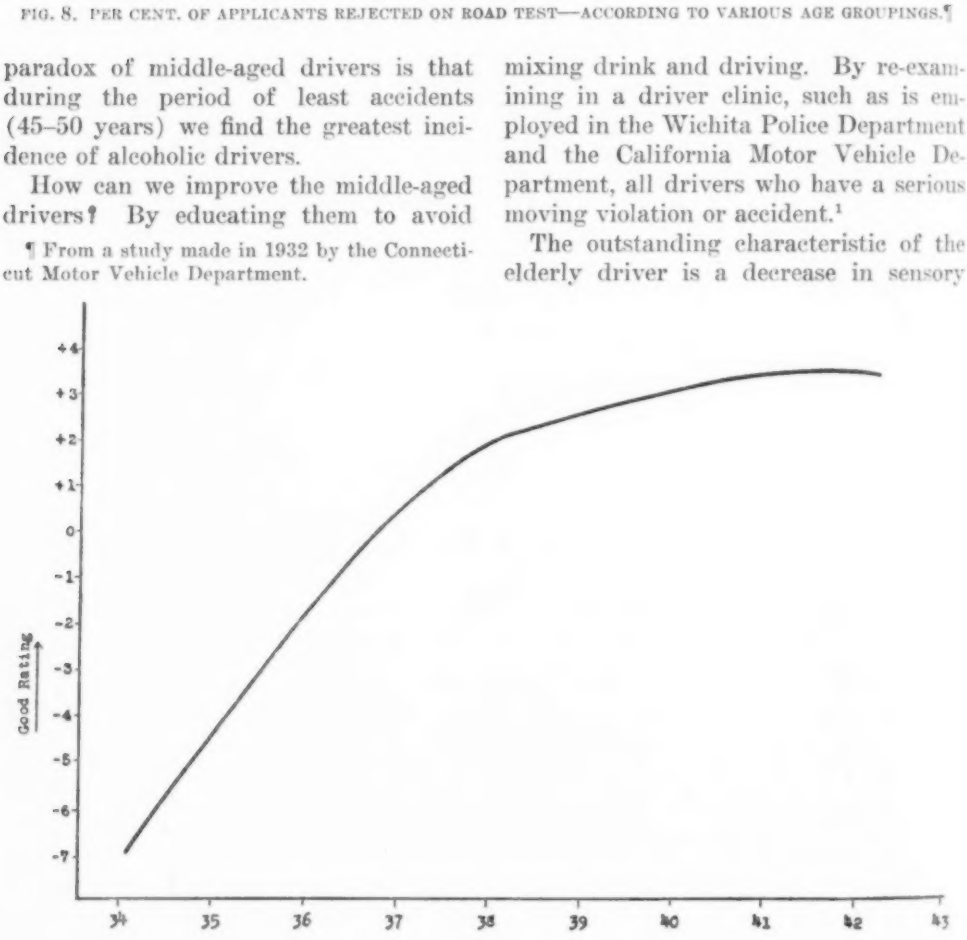


FIG. 9. COMPOSITE SCORE.

capacity and motor coordination. He is, accordingly, less able to handle himself, particularly as a pedestrian. On the other hand he has had much more experience in driving than the younger driver, and should be better aware of his own shortcomings as well as the defects in his car and the hazards in the road. Older persons, owning more cars and heading families, possess a keener sense of social responsibility, which is at the basis of driving courtesy and caution. On the other hand, many of them have never taken a license examination, nor learned to adapt themselves to the tempo of modern driving. Although they may not themselves get into so many accidents, on account of their slower speeds, more leisurely habits of turning corners and more cautious operations at intersections, they may, by hindering the steady flow of traffic, cause others to have accidents.

How can we help persons in their fifties and sixties to continue to drive as safely as they did in their forties? They can not be legislated into safety. Neither can they be browbeaten to drive more safely. Rather they must be approached individually and given objective facts about their failing abilities and how to adapt their driving to offset them. The driver clinic is more important for elderly persons than for younger persons. Detecting weaknesses not in one or two respects but in many respects the clinic supervisor can effect a better cure. Drivers like sick men can be cured best by helping themselves. When faced by objective facts old persons can carry out just as successful a self-improvement campaign as young persons.

[1] "Driver Testing Results," Monograph, *Harvard Traffic Bureau*, 1937, 98 pp. "Wichita Police Clinic," *Public Safety*, August, 1937, pp. 8–9: 45. "Clinical Treatment of Traffic Violators," *Police Journal*, December, 1937, Vol. XXIV, No. 2, pp. 3–7. "Driver Clinics in the Field," *Journal of Applied Psychology*, February, 1938.

SCIENCE BY RADIO

By Dr. F. R. MOULTON

PERMANENT SECRETARY, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

In these days of rapid political, economic and social changes, probably the most rapid and dangerous civilization has undergone, no one need apologize for attempting to place before the general public not only the facts but also the methods and the spirit of science, for science and its applications are the principal factors that are now transforming the world. Since the progress of science depends upon the social order, the relations of science and society are reciprocal. Consequently, the American Association for the Advancement of Science, which is dedicated to the promotion of science, is true to its declared purpose, even in the narrowest sense, when it serves the interests of society. But it is not necessary to insist on this reciprocal relationship between science and society, for the broad mission of the association is to advance the interests of civilization.

During most of its history the association was able to serve directly only its members and a limited number of other scientists. In recent years, however, noteworthy features of its meetings have been effectively and increasingly placed before the general public by the daily press. Now an amazing new means, the radio, is available for reaching the masses. Since January 19, 1938, the association has spoken weekly over the blue network of the National Broadcasting Company to all throughout the country who have cared to listen. Now fifty-seven broadcasting stations carry its programs under the general title "Science on the March," on Monday evenings at 7:45 Eastern Standard Time.

The "Science on the March" broadcasts are an experiment in mass education in the broad fields of pure and applied science. They have not presented science as magic or scientists as heroes. They have not attempted to startle the listeners or to represent science as consisting only of breathtaking discoveries. Such methods would violate the very spirit of science and encourage beliefs in magic not only in science but also in all the affairs of life. They would prepare the way for mass hysteria such as that which swept over the country in terror of an invasion by utterly fantastic creatures from Mars. The broadcasts of the association represent science rather as enthusiastic and joyful, yet sane and systematic, explorations of the universe about us and in us. Disavowing beliefs in mysteries and magic, they advocate confidence in experimentation and the processes of reasoning.

Ideals are one thing, and their accomplishment is often quite another. And so it is with education by the radio, for the radio has so recently become available that its possibilities are practically unknown. It is so different from other methods that previous experience is of little value in attempting to use it. An obvious advantage that it has is that an exceptional teacher may reach simultaneously an enormous number of persons of all ages, occupations, education, cultural background and intelligence. An obvious disadvantage of the radio in education is that it provides only one connection between the teacher and those who are taught, and that connection is one-way, brief, leaving no permanent record and without opportunities for repetitions. Clearly a means of education that is so new, that offers certain very great advantages and that is beset by serious difficulties deserves careful consideration and a large amount of experimentation. As has been remarked,

the broadcasts of the association are in the nature of an experiment in mass education in a difficult field.

Before the "Science on the March" broadcasts were initiated the method of their presentation was given considerable attention, and the final plans for them were agreed upon in a conference with Dr. James R. Angell and Dr. Franklin Dunham, of the National Broadcasting Company. Every one agrees that the first principle in education is to cause the learners to think. Socrates became perhaps the most famous teacher in history, not because of brilliant lectures or carefully prepared outlines of courses, but because he taught those who sat at his feet how relentlessly to doubt and to question and to work out their own answers. And it is true that all the great teachers whom we have known or whose reputations have come down to us have stood out above other members of their profession because they followed essentially the same method. This attitude has always been the chief characteristic of great teachers whether their special interests were in the dead languages or philosophy or science or theology—whether they looked back over the past or sought to penetrate the future. In this method two minds strive together and sometimes clash on terms of approximate equality.

Since over the radio it is impossible for the teacher and the person taught to sit together on a log and discuss the questions in which they are interested, the participation of the listener must be vicarious, as it is in the printed story. In a good story the reader identifies himself with one of the characters. The adventures, the hopes, the anxieties, the failures and the triumphs of the hero are his. The satisfactory hero sometimes is foolish and makes mistakes, he sometimes is discouraged, but he persistently rises above difficulties and in the end he triumphs. He must have some human frailties or the reader can not identify himself with him; he must have some heroic qualities for the reader to look up to as a standard.

In formulating plans for the broadcasts of the association, the advantage of the method of Socrates was kept always in mind. The attempt has been made to make the listeners participants in the discussions rather than simply recipients of what has been said. Since they can participate in the broadcasts only as readers of a book take part in its story, a leaf has been taken from "Pilgrim's Progress" and "The Last of the Mohicans" and "Little Women" and other books that have profoundly influenced the lives of the youth of our land. The speaker and the announcer are the characters, the latter representing the listener. In Socratic fashion they question and argue, sometimes following false trails, sometimes reaching premature conclusions on insufficient evidence, often triumphing, but sometimes being compelled frankly to admit that they do not know the answers to the questions they are considering. That is the way it is with scientists and with all honest, inquiring minds.

Such are the ideals, but the broadcasts often fall far short of realizing them. It is a somewhat onerous burden to prepare and deliver at a fixed time a broadcast week after week in the midst of many other duties. Often the inspiration for the right touch is lacking. Sometimes the choice of subject is not fortunate. Sometimes a broadcast is too elementary for some listeners and too stilted for others. There are very many ways in which to fall short of success. Yet letters from many listeners prove that the broadcasts have achieved a considerable measure of success. Between January 19 and October 1, 170,600 copies of scripts of the broadcasts were sent out free of charge to those who asked for them with the help of a grant from the Carnegie Corporation of New York in aid of the educational work of the association.

In order to obtain specific information respecting the public that was interested

in the broadcasts and the use that was being made of them, in June a somewhat detailed questionnaire was sent out to about 8,000 persons. Nearly 2,000 of these persons took the time to reply to the questions and went to the expense of returning the questionnaire. Of these replies, 1,250 were chosen at random and the answers and the voluntary remarks they contained were tabulated. The following is a summary of the results:

1. *Occupations of listeners*	Per cent.
Business and clerical work	16.6
Professions exclusive of teaching	11.8
Farming and housekeeping	7.2
Teachers	10.3
Students	35.2
Skilled labor	8.0
Unskilled labor	3.1
None (retired, unemployed, invalids)	5.6
Occupation not given	2.2
	100.0

2. *Education of listeners*	
College degree	28.1
High-school graduate	21.4
Grade-school graduate	6.9
In school at present	35.2
Education not given	8.4
	100.0

3. *Conditions of listening*	
With family or friends	60.7
Mostly alone	33.9
With science clubs, classes, scouts	3.1
Not able to listen but use scripts	1.8
	100.0

4. *Use of printed scripts*	
File for personal or family use	71.7
File for friends, employees, customers	8.9
Use in science clubs, schools, scouts	27.8
Use for lectures, sermons, rebroadcasts	.3
Dramatize or read aloud at home	12.8
Dramatize or read in clubs or scout meetings	2.7
Dramatize or read at school	6.1
Dramatize or read at other places	5.8
Total, including duplicate uses	136.2

5. *Discussions of broadcasts*	
In homes	51.1
In schools, clubs, churches	31.1
At work and with friends	6.8
No information given	11.0
	100.0

6. *Suggestions and requests*	
Organization of radio science clubs	44.9
Inclusion of lists of books and magazines	19.1
Broadcasts in school hours for students	1.9
More frequent or longer programs	5.0
Questions to be answered	1.1
	71.9

7. *Subjects requested for broadcasts*	
Astronomy	21.1
Geology, etc.	14.4
Medicine	11.1
Chemistry	10.3
Physics	9.9
Biological sciences	8.7
Recent scientific discoveries	8.5
Scientific theories	7.0
Biography of scientists	4.7
Radio and television	4.3
	100.0

Among the many interesting facts contained in this summary, the most significant is that more than 60 per cent. of the persons reporting listened to the broadcasts with family and friends. These were more than casual family gatherings, for in more than 51 per cent. of the cases the broadcasts were discussed in the homes of the listeners. Indeed, in about 13 per cent. the printed scripts were later read aloud. It is doubtful whether there is any more satisfactory form of general education than free and informal discussions around the family fireside without any compulsion or even the formalities that are necessary in schools. Many of the applications of science tend to weaken family ties; perhaps the radio can be made a very important force in restoring them and raising them to a higher level. If so, it may become for this reason of great service to our civilization.

Of similar import is the fact that nearly 28 per cent. of those reporting use the printed scripts in science clubs, schools and scout meetings, and that more than 31 per cent. discuss the broadcasts in clubs, schools and churches. Consequently, these experiments make it clear that broadcasts may help not only to unify the family but also to integrate community life.

COMMENTS ON CURRENT SCIENCE

By SCIENCE SERVICE[1]

WASHINGTON, D. C.

"MONSTERS" TO MARS

If "monsters" from Mars should ever descend upon the earth and spread destruction, as a recent broadcast represented them as doing, an obvious counter measure would be for all terrestrial nations to combine and retaliate by sending "earth-monsters" to Mars. As a precautionary step the basic scientific facts on which the project would depend should be worked out well in advance of their need. Some of the dynamical principles involved and the difficulties which would be met will be enumerated. Even if the idea of an invasion from Mars or of a retaliatory expedition from the earth is fantastic, it raises interesting scientific questions that have astonishing answers.

Inasmuch as the "earth-monsters" would have to pass through at least forty million miles of vacuum, it would be necessary for them to be enclosed in an air-tight vessel of some sort, presumably a sphere. To serve its purpose the sphere would have to be large enough to hold a considerable number of the "monsters." A conservative estimate would assign it a diameter of twenty feet, and the materials of its walls would have to be strong enough to withstand the strains to which it would be subjected.

The first question to be considered is the thickness of the walls of the sphere that would be necessary. Under the assumption that normal atmospheric pressure would be maintained in the interior of the sphere, we find that when it got out into a vacuum the total outward pressure would exceed 2,700,000 pounds. Naturally this pressure would tend to rupture the sphere, but we find that if it were made of good steel a thickness of one tenth of an inch would give a good margin of safety. With this thickness the empty sphere would weigh about 4,800 pounds.

A serious difficulty arises, however, in getting the sphere out into space free from the gravitational control of the earth. It is well known that if it were simply shot outward, it would have to leave the surface of the earth at a velocity of seven miles per second in order to escape. In fact, it would have to be projected outward at a much higher velocity, for seven miles a second is the velocity that would be necessary if there were no retarding atmosphere. Now seven miles per second is approximately ten times the muzzle velocity of a very high-power gun, and no method is known of producing such a speed, or even one quarter of such a speed, in a projectile.

Let us ignore the serious difficulty of starting the sphere out from the surface of the earth at a velocity of seven miles per second and consider the resistance of the atmosphere to which it would be subjected. At this high velocity the atmospheric resistance would be about 23,000 pounds per square inch, or a total of more than 500,000 tons on the forward side of the assumed twenty-foot sphere. Therefore a sphere one tenth of an inch in thickness would fall short of being strong enough. Moreover, the resistance of the atmosphere would be 200,000 times gravity, and consequently for the sphere to escape from the earth its initial velocity would have to be much greater than seven miles per second, perhaps ten times as great, or a hundred times the muzzle velocity of a high-power gun. But since the atmospheric resistance increases with the square of the velocity, it would rise

[1] With the exception of the two signed statements these notes have been prepared by Science Service; Watson Davis, director, Frank Thone, Robert D. Potter, Jane Stafford, Emily C. Davis and Marjorie Van de Water, staff writers.

to a height which no known material can withstand. Consequently "earth-monsters" can never be shot outside the earth's atmosphere.

There is, however, another possibility to be considered, that of a huge rocket which propels itself by shooting backward part of its material. That there is something in the idea is proved by the success of sky rockets on every Fourth of July. The principle involved is illustrated by the kick of a gun when it is fired: the projectile goes forward at high speed and the gun backward at low speed, the velocities being inversely as the masses. Or, otherwise stated, the product of the mass and the speed of the projectile in one direction equals the product of the mass and the speed of the gun in the other direction, except for slight effects of expelled gases and attachments to the gun. In the case of heavy artillery, such as is used on naval vessels, elaborate means must be provided for taking care of the recoils of the guns. An obvious advantage of a rocket is that since the propelling force is applied gradually, high velocities, and consequently large resistances by the atmosphere, are not developed. On the other hand, all the materials that are projected backward during the flight of the rocket must be carried along at a great cost of energy until they are used. In order to get some idea of the practical aspects of the problem, it will be assumed that the twenty-foot rocket is launched with an initial velocity of only one quarter of a mile per second, which is well within the muzzle speed of guns, and that enough material is fired backward to maintain that velocity until the rocket has reached an altitude of one hundred miles, beyond which there will be no appreciable amount of atmosphere. At a speed of one quarter of a mile per second the atmospheric resistance to the rocket at the earth's surface would be 1,300,000 pounds and, gradually diminishing with altitude, would vanish at a height of one hundred miles. The gravity of the earth would be sensibly constant to even a much greater distance from the surface.

In order to get the rocket beyond the earth's control there are two forces to be overcome, the resistance of the atmosphere and the backward pull of gravity. The work that would have to be done in moving the rocket against the resistance of the atmosphere from the surface of the earth to a height of one hundred miles would be, under the assumption of a constant speed of one quarter of a mile a second, thirty billion footpounds. If the rocket with its load weighed ten tons, which is less than the weight of a twenty-foot hollow sphere with even a half-inch steel shell, the work required to get it beyond the control of the earth's attraction would be 420 billion footpounds. Consequently, in order to get the rocket out through the atmosphere at a velocity of one quarter of a mile a second and beyond the control of the earth's gravity, the material shooting back from it would have to do on it 450 billion footpounds of work. But to do this enormous amount of work would require, even at 100 per cent. efficiency, as much energy as there is in sixteen thousand tons of coal. Since a rocket weighing only ten tons could not carry an initial load of sixteen thousand tons, the impossibility of "earth-monsters" going on a successful expedition to Mars is quite evident. And the difficulties in the way of "Mars-monsters" getting free of that planet are comparable, not to mention as serious ones in traveling many millions of miles through interplanetary spaces. So let the silly season for "Mars-monsters" come to a close.

F. R. M.

HUMAN CONSERVATION

CONSERVATION of America's mental health should obviously be one of the first concerns of the nation. Yet it is receiving much less attention at present than is the conservation of soil.

The functioning of a democracy presupposes that the citizens must be intelligent, informed and in their right minds. Yet, an estimated 1,500,000 persons in the United States are mentally defective. Another 1,500,000 to 2,000,000,000 are mentally diseased.

Mental disease is America's worst health problem. Six of every ten hospital beds are occupied by mental patients. Unknown numbers are being cared for outside institutions. Yet the facts behind mental disease are as unknown scientifically as are the facts about cancer.

An extensive series of surveys of mental health in typical American communities is strongly urged by the Committee on Population Problems of the National Resources Committee, whose report has made public these facts.

Such surveys might assay the nation's intellectual resources, reveal the need and suggest methods for conservation, and possibly throw light on disease causes.

Economic factors, including unemployment, may be found to contribute to mental breakdown, and the differential birth rate which brings the largest families to the worst homes may be found to contribute alike to mental defectiveness, mental disease and social inadequacy.

"In the past we have as a nation considered our natural and our human resources alike to be virtually inexhaustible," warns the committee. "It has come as rather a shock in recent years to learn that the acreage of formerly fine farm land that has been permanently destroyed runs into a staggering number of millions.

"In exactly the same way our human heritage is not inexhaustible. Millions of years have gone into building it up, just as in the case of the soil. The possibility of the wastage of genes favorable to human development through social conditions causing adverse selection suggests a more serious national problem than any amount of soil erosion."

The development of a "human conservation" policy is urged.

WHY LEARN TO READ?

WHY learn to read?

Modern invention is fast minimizing the need for ability to recognize the printed word. The radio has done away with need for reading the newspapers; even the comic strip is presented over the air. Fiction comes to you in sound movies.

You can now buy excellent magazines containing whole stores in pictures. Even if you are a historian, important events are recorded for you in motion pictures. The voices of great men may bring their messages to you on sound film or phonograph records.

Even the letters of friendship or business may soon be outdated by mailable dictating machine records on which the sender can speak directly to his correspondent.

Seriously, it is proposed by Dr. Arthur Lichtenstein, of the Johns Hopkins University, who has had the problem of teaching reading to those who can not learn, that we modify the school curriculum so as to lighten the burden for those lacking in literary aptitude.

The story of Rae is told by Dr. Lichtenstein in *School and Society*, where this revolutionary proposal is made.

Rae was a "nice, friendly boy, making every effort to succeed, and a great help around the home."

Rae's troubles were due to the fact that at ten years he was unable to pass the second grade reading test. Despite this handicap his intelligence was normal. Every effort was made to teach him to read.

Four years later his IQ had dropped 15 points. He had gained 18 months in mental age in the four years and in silent reading he had lost two months.

"The time spent in attempting to make a reader of Rae was wasted," comments Dr. Lichtenstein. "Fortunately,

no greater harm to his personality appeared to result than the development of a marked inferiority feeling and dislike and apprehension in the presence of a reading situation.

"Had reading been relegated to a minor place in his program instead of the all-powerful bugbear it became, he would be just as well off educationally and far better off from a mental hygiene point of view."

WATERSIDE IMPROVEMENTS

WITH a new public works program about to get under way, it is worth while taking a critical look at plans for some of the improvements that are intended at once to make our communities more livable and to give jobs to the unemployed. Too often, public improvements have been synonymous with wholesale destruction by grader and steamshovel.

Recently a group of European conservationists and landscape engineers got their heads together and drafted a set of rules to be consulted when waterside improvements are being made. Their suggestions are worth pinning on the walls of local public works committees—and pasting in field supervisors' hats:

(1) Improvements should leave the landscape as nearly as possible in its original state, or at least able to return to that state very quickly.

(2) River courses should be changed only when absolutely necessary; and then they should not be made rigidly straight, but laid out in gradual curves.

(3) Islands, as ideal breeding places for wildlife, should not be destroyed or disturbed.

(4) Streamside vegetation should be left undisturbed as far as possible. If a stream must be widened, the cut should be made on the side with the least timber.

(5) When trees and shrubs must be removed, they should be replaced immediately, preferably with native species.

(6) New banks on a cut should be of natural materials, such as sod, brush and broken stone; concrete walls are to be avoided.

(7) Natural lakes and ponds should not be drained or destroyed, and their shore vegetation should either be left undisturbed or restored to its natural state as quickly as possible.

(8) Planners should carefully consider whether projected improvements will cause a lowering in the water table.

(9) Bridges, dams, etc., should utilize local material as far as possible.

(10) Long, straight lines in dikes, levees, etc., are to be avoided.

(11) Drainage projects should spare trees and shrubbery.

(12) Definite plans should be fully worked out before digging begins.

ON THE SANDS OF TIME

KENNETH JONES, village carpenter at Mortlach, Saskatchewan, hunts Indian arrow heads in his spare time. For some years now he has been picking up curious chipped flint spear heads, accounts of which sent Dr. Frank H. H. Roberts, Jr., Smithsonian Institution archeologist, on a flying visit last month to the little Canadian town. The pieces of stone were Folsom and Yuma points, artifacts of men who lived in North America at least as early as the later stages of the last ice age—probably as much as ten thousand years ago.

Dr. Roberts found himself in a dismal country wrecked by draught and wind, the Canadian dust bowl. But at some time in the distant past it had been a pleasant land with little lakes strung like amethysts down a long valley. It was then very likely, Dr. Roberts believes, that the ancient nomad hunters, who were the first human beings to leave any traces of themselves on this continent, camped there.

The Saskatchewan carpenter's spearhead collection may prove a key to a hitherto impenetrable chapter of history. The ancient hunters themselves or their direct ancestors undoubtedly came into

the interior of North America from Asia by way of Alaska. For five summers Dr. Roberts has been excavating the site of one of their camps in northeastern Colorado, which, it has been demonstrated by geological evidence, was just at the edge of the retreating glacier, from which summer streams created lush meadows in which grazed great herds of an extinct species of bison and camels, musk oxen and a few mammoths.

How did men get there? To the north was a limitless waste of ice like the interior of Greenland to-day. Human beings hardly could have made their way across it for thousands of miles, even in many generations. The only possibility is that there was a broad, ice-free corridor, for which there is considerable geological and botanical evidence, at some time during the Pleistocene, which would have included the Canadian dust bowl.

This may have been the time when the nomad hunters, on their slow way south, camped around the Mortlach lakes, and in this case the curio-collecting carpenter may have hit upon the earliest trace of human beings in North America. Otherwise, Folsom man must have waited for the retreat of the ice to get there, for there is geological evidence that the corridor was closed during the last part of the Pleistocene.

Unfortunately the evidence is vague. The winds have wrecked any semblance of soil stratification in the area so that the finds can not be dated. But, somewhere in Alberta or Saskatchewan there may be an undisturbed site where Folsom man camped, and whose fortunate finder will have hit upon one of the key spots of North American archeology.

THOMAS HENRY

ALGAE AS SOURCE OF FOOD

MOST of us, even though we may claim no great degree of botanical knowledge, can recognize the lesser plants, fungi and mosses, when we see them. But mention algae, another great group of the humbler, flowerless growths, and we feel a bit lost. We aren't quite sure what algae are.

To bring popular knowledge of this important but neglected province of the plant kingdom up even with that of plants in general is the task which Professor L. H. Tiffany, of the University of Illinois, has set for himself in his new book, "Algae: the Grass of Many Waters" (Thomas).

Algae are not grasses, in the strict botanical sense of the term, the author points out. They rank far below grasses in the hierarchy of systematic botany, indeed sharing with fungi the lowest rung of the evolutionary ladder. Yet styling them "grass" is justified from the ecological point of view, because of their function in the life-complex of the waters. If it is true on land that all flesh is grass, it is equally true in the water that all fish is alga.

Algae form the fundamental food in the long chain of eat-and-be-eaten that begins with some almost invisible gnawers like minute worms and water-fleas and builds up at last into salmon and sturgeon, walrus and mighty whale. Most of us know algae mainly as the highly unappetizing green scums that form on stagnant ponds; we do not recognize in it the fish-fodder that eventually turns up on our tables after many digestive metamorphoses.

But algae are not just fish provender. They come to our notice, and affect our lives in a score of other ways. They form green mats and scums on the soil and apparently cooperate with bacteria in fixing atmospheric nitrogen as free fertilizer. They form the green "moss" supposed to grow only on the north sides of trees. (Actually it grows on any damp side of the trunk.) Fossil beds of their silica shells provide scouring powder. Algae have even been found inhabiting our own important interiors.

THE RUINS OF HITTITE PALACES

THE mysterious Hittites are not nearly so mysterious as they used to be. Archeologists are persistently digging up Hittite cities in Asia Minor and Syria to the north and northwest of Palestine. As a result, Hittites are now classed respectfully with the big powers of antiquity, and their two eras of expansive empire, when they dominated wide regions of the ancient world, are being restored in some detail to pages of history.

One gap in knowledge of Hittite fortunes has been the time between 1650 B.C. and 1400. That was between the two great empire eras, when Hittite kings seem to have lacked the militaristic urge to power.

So, it is a red letter Hittite day when Sir Leonard Woolley, excavating for the British Museum at Atchana near Antioch in northern Syria, finds a Hittite palace built about 1600 B.C. and burned near 1400.

Whether the era was considered a time of fortunate peace or one of weak depression by people in those days, the palace ruins at Atchana suggest that Hittite rulers there lived well and conducted business as usual.

Wrecked by fire though it was, the palace ruins tell a lot to an archeologist. Sir Leonard identifies suites of rooms with bedroom and bath and points out women's apartments marked by the combs, pins, trinkets and toilet boxes in the debris. Other rooms containing little besides clay tablets and wine jars are presumed to belong to scribes—the secretaries and clerks of the palace.

In one annex to the palace is a suite of work-room, bedroom and lavatory, which belonged apparently to the archivist, since a room built especially for storing records is near it. Most of the tablets stored here were removed in the fire 3,400 years ago, but elsewhere in the annex offices about 300 clay documents awaited the archeologists of 1938. These may add history of the obscure era.

THE APPRECIATION OF MUSIC

LOVE for music can be explained by the psychologist. Dr. Carl E. Seashore, of the University of Iowa, who as psychologist has for years been studying and predicting musical ability and appreciation, scouts the idea that love for music is an inexplicable emotion.

Love of music can be accounted for on five grounds, he writes, in the *Music Educators Journal*. The first reason is physiological. We have an organism that registers music and responds to it somewhat like a resonator. Not only the central nervous system is affected, but the peripheral nervous system, all the muscles, all the internal organs, and especially the autonomic system with its endocrines which furnishes a physical basis for emotion. The whole body is put into a glow of well-being by the pleasure of hearing musical sounds.

A single sound may be beautiful in itself, like a flower or a human face. The untutored mind and the musically trained can alike delight in their charm quite apart from their utility in building up musical form.

Delight in "harmonic structure, the melodic progressions, the rhythmic patterns, the qualitative modulations, in the flow of beautiful sounds" is another reason for love of music. Music carries us through the realms of creative imagination.

We love music also because it is the language of social bonds. Music is a message and can move the social group into concerted action and into a feeling of common fellowship.

Finally we love music because it is a means of self-expression. It furnishes us with the joy of putting into a fitting medium our love, our fears, our sympathy, our feelings of fellowship, our communion with the Divine.

On these five fundamental grounds, says Dr. Seashore, rests the psychologist's adequate explanation for why we love music.

NEW CURES FOR OLD

By Dr. JAMES FREDERICK ROGERS
OFFICE OF EDUCATION, WASHINGTON, D. C.

IN man's earliest endeavor at finding the source of his aches and pains, his fevers and his prostrations, it was a somebody, not a something, that got the blame, and that somebody (as real to him as hand or foot) was not the sufferer himself, but an evil spirit lurking around the corner with nothing better to do than to take delight in hurting one's head or lighting fires within one's frame. The cure? Anything that would drive away the torturing demon.

Now devils, like other folk, should resent the disagreeables, so the man for the occasion—the healer—the medicine man of the tribe—logically assailed the eyes of the evil spirit with his horrid appearance and his dreadful antics, battered the spirit's ears with the noise of his tom-tom, provoked the spirit's nostrils with the odors from decoctions of noisome things, and befuddled the spirit's mentality with puzzling jargon. The malevolent spirit often (though sometimes with due deliberation) betook himself elsewhere. At any rate, in many cases, the headache passed, or the fever subsided, and the medicine man received the credit, with, incidentally, some remuneration for his valuable services. That he was not always successful was no matter of wonder. Some spirits must be especially stubborn. Moreover, had he always effected a cure there would have been, there and then, an end to the evolution of therapeutics, there would have been but one kind of medicine man—and this story would never have been written. Paradoxically, progress in cures was the outcome of failure to cure, and failure to cure meant, likewise, further study and revision of ideas of ailments.

And it came to pass that the chief of the tribe fell sick after a feast, the medicine man was called and did his best but without results. The sick man grew worse rather than better. By a stroke of ill luck, the man of medicine had more than one failure to his credit. The chief was told of a healer with ascendant star, in a neighboring tribe. The latter was sent for. Medicine Man Number Two consulted with Medicine Man Number One—*the first consultation*. Strange, their ideas and methods agreed—their horribles were identical. It was evident that the resources of the old school had been exhausted so far as the case in hand was concerned. But the reputation of all medicine, as well as the lives of these medicine men, were in danger. Something must be done. A cauldron for incantation containing a decoction of loathsome things—dung, toad's eyes, snail slime—was handy. Why not drench the evil spirit from the chief? It was a daring venture, but it worked like a charm—better than a charm, for charms had been tried. The noisome beverage was hardly down before it was up, and with it the undigested meal. A new era in medicine had set in—the age of drugs.

The new field was practically unlimited. The animal, vegetable and mineral kingdoms were ready to be ransacked for new cures as fast as the old ones failed. New drug after new drug had its day for hundreds of years until, from mandrake to musk and from calomel to cod-liver oil, they were gathered from the ends of the earth. They filled the bottles and stuffed the drawers of the apothecary from floor to ceiling. It's a long and interesting story. The magic of the old order clung for a long time to the new, and materials for pellets, powders and

potions worked more wonderfully as they were gathered in witching hours, in the appropriate phase of the moon or in magical neighborhoods. The drugs that might be (and have been) tried were legion, and when they failed singly, there was always the possibility that a new combination of them would prove effective. If one would not cure, certainly a half dozen of them, carefully compounded, would do the work. The physician and the apothecary, as well as the patient, honestly believed they would produce a cure, and often, as in the days of the noisier and more spectacular medicine men, the sick got well. In fact, some of the means used were genuinely helpful and in process of time have proved their worth.

And a new magician arose, even in the nineteenth century, who said, and doubtless believed, that he increased the potency of a drug by dilution—until a drop of the substance, as formerly dosed, added to a pail of water was pronounced more powerful for good (it was certainly less potent for harm) than the unsublimated substance. The "homeopathic" dose cured—on many occasions and it had always the quality of harmlessness.

The end of drug cures is not yet, for there was some small good in the long line of emetics, cathartics, diaphoretics, diuretics, antispasmodics, hypnotics, emollients, digestants, demulcents, alteratives, etc.,—in large or in small dose, singly or in combination, concentrated or dilute, applied externally or taken internally, sold in plain packages or in containers of attractive shapes with costumes of many designs, prescribed by physician or by pharmacist, advised by their recipients or advertised in the daily news.

To return again to earlier times—the chief was sick. He had a splitting headache for which neither incantations nor drugs availed. Something new must be tried. A medicine man of rare imagination (imagination has been the source of all scientific achievement) suggested that the reason why the evil spirit did not avaunt was that he had become imprisoned in the royal skull. Or maybe there was another more scientific theory. Had not the head of the head of the tribe bothered him since his last battle, in which he was banged on the cranium with a stone axe? It was a bold undertaking, but there is ample evidence that at a most primitive time the operation of trephining the skull, with implements of stone, was done and done successfully—with survival and with cure. Surgery was begun, and with ups and downs has reached its present state of development. The modern surgeon is sometimes daring, but by no means ever so fearless as he, who, in remote time, without anesthetic, opened the skull of his patient with a sliver of flint.

The blood was noted by physiologists of early days as something necessary to life and, hence, of much concern for health. They named it "vital fluid." There might be too little of it, they thought, and maybe there might sometimes be too much of it. Did not a flushing of the face and beating of arteries of the neck accompany headaches, apoplexy and fevers? Then there was phlegm. It needed no anatomizing to discover that there might be too much of that. A cold was nothing more nor less than an excess of this "humor." Then bile—there must be something very significant about this, for often there was "too much" and it "came up." We were "bilious." Or maybe it turned dark when we were blue or we were blue because the bile was not yellow bile but "melancholy" or black bile, for melancholy means black. "Sanguine" (too much blood), "phlegmatic" (too much phlegm), "bilious" (too much bile), "melancholy" (too much black bile)—how familiar the terms, though they are thousands of years old and have been the basis of theories and cures galore! In how many of us are those four "humors" so nicely proportioned

that we are neither too melancholy, too bilious, too phlegmatic or over-sanguine, but just "good-humored"?

The cure by drugs fitted well into this old Greek scheme of human ills. Biliousness, in particular, still has such remedies, which work as magically for this nomenclature as under the less ancient and less elegant explanation of constipation. There were medicines to "dry" the blood and to "thin" the blood, but to reduce its menacing quantity and to rid the body of bad humors, drugs were too slow and uncertain. It seemed vastly more expeditious to "open" a vein. Phlebotomy, with or without accessory helps, became a cure for everything. For many centuries everybody was "let blood" on general principles, every spring, and, for what ailed them, at all seasons.

Far back—even before man's emergence from lower animal forms he found it "helped a lot" to rub an injured part of his body. Indeed, to "scratch himself" against a tree was an age-long animal practice, but to have some one stroke an injured part or to rub one's back or one's limbs when one is tired is better than medicine. Massage, gentle or severe, stroking, rubbing, beating, slapping, has, for thousands of years, had its ups and downs as remedies for all manner of ills, and for many of our ailments, such manipulations and passive exercise have been very helpful. Napoleon found mechanical therapeutics to his liking, and the Moslem masseur he discovered in Egypt earned his board and keep, for Napoleon kept shouting to him, "Rub harder, harder, as if you were rubbing an ass!"

Cures by exercise (not done by proxy) have also flourished and still do so, from Delsartian waving of arms to the lifting of heavy weights. "Systems" of exercises, with and without apparatus, each guaranteed to cure all ills and raise man to perfection have had their day and ceased to be.

To return to the beginning of another species of cure. Man, or some of him, became so matter of fact that, instead of blaming the spirits for his ills, he conceived that he himself (being possessed of "freedom of the will") might sometimes bring upon himself his own ills. His stomach was a frequent source of bother. Was it altogether to blame? We, like cattle, have grinding teeth—why, then, it's evident we should do best as vegetarians. But having pointed canines, like those of the dog, maybe it is meat we need. But do not our chisel-shaped incisors serve best for fruits? Maybe we were meant for that diet. Cereals, vegetables, meats, fruits, have all been classified according as they affect our "humors"—as to whether they are too "moist" or too "dry" or too "hot" or too "cold" for the good of the consumer. It is all set down in those interesting old health books with such charming titles as: "The Castle of Health," "The Mirror of Health," "The Highway of Health," etc. Raw food faddists, the cooked food faddists, the masticators, the one-mealists, the two-mealists, the grape cultists—the dietary changes have all been vigorously rung.

And drinks! The taking of wine for the stomach's sake is older than Saint Paul; rock and rye were said in their day to have done wonders, while even water, "mineral" or plain, applied internally or externally, has had endless cures to its credit. Possibly these latter reached their height of fashion in England and Germany before the war.

A cold bath has an undoubted effect. We gasp, we shiver, our heart beats faster, we feel different. May not the cold bath be what we need for things that ail us? Yes, here is a list, taken from a popular book of the eighteenth century, of some of the ailments it will (or once would) "cure."

Convulsions	Rupture
Vomiting	Suffocation
Rickets	Sciatica
Gravel	Rheumatism
Insomnia	Torpor
Ague	Tetanus
Lethargy	Scorbutus
Loss of appetite	Vertigo
Pain in the back	Varicose ulcers
Pain in the joints	Headaches
Atrophy	Sore eyes
Epilepsy	Hydrophobia
Incubus	Surfeit (at the beginning)
Leprosy	

Why seek further for a cure? There are volumes that tell of hydrotherapeutics in other forms—from walking in the dewy grass at dawn to a hot tub bath at bedtime.

Light seems essential; heat is necessary to life. Why not cures of disease by sunshine, by electric-light baths, by red lights, blue lights, green lights? They all have "cures" to their credit, as has electricity in all its forms—galvanic, faradic, static, high frequency, "animal magnetism," with that weird personality, Mesmer, as the outstanding, picturesque apostle of such treatment.

The first medicine man made music over the sick. So ever since, there has been reversion to music cures, and even of late, following the wholesale methods of the age of machines, there have been established music clinics where one may be soothed or stirred, changed, certainly for the time being, by floods from "music's golden sea."

But maybe it's the air that ails us? It was the "mala aria" air (bad air) that once caused malaria. At any rate, a "change of air" may help us—Egypt, the Riviera, Switzerland, New Mexico, California. There was something in this for some people, but alas, as Mark Twain so aptly put it, for most of us, "climate is our human environment." The best climate is bad without congenial company of our kind, and this is not always forthcoming. But if it's not the air, it's your method of use of air. Have you tried Ben Franklin's air bath—sitting in your skin for a season before you dress? Or have you done breathing exercises? These are (or were) good for all your ills—if you learn the prescribed technique.

But if air itself is not bad, what carried contagion? It was long ago guessed that plagues were conveyed, not so much by the air, as more directly from sick to well. The leper and his like were called unclean and were driven apart. There was a mysterious something that was conveyed by humans themselves and which might cling to human habitations. Long before the germ of tuberculosis was discovered, the composer, Chopin, dying of consumption, was obliged, by order of the local authorities, not only to repaper but to replaster a mansion from which he had moved. The plagues from the hand of God were finally discovered to be plagues from the hand of man. The microscope has revealed the thing that often ails us and has made us blush over the absurdity of many once-believed-in means of cure.

With all this kaleidoscopic evolution of notions of disease, from possession by a demon to infection by fungi, no universal cause and no universal cure has come to hand. Perhaps, after all, there is no such thing as disease. Haven't we been chasing a will-o-the-wisp? Haven't we been merely imagining bodily distress and merely "seeing things" when we look at a cancerous stomach or a lung riddled by tubercle bacilli? There are "healers" who take this view and work their "cures." Though their practices are less spectacular, they remind one strongly of the first medicine man mentioned in this essay. Has the race, or a part of it, entered upon its second childhood?

All these bewildering myriad cures resulted, as mentioned previously, from failure to cure, but back of this was the fact, now well known, that the human body has the ability, if not too hard hit

by accident or disease, of getting rid of the cause of its ailment and of repairing (within limits) the damage that has occurred. In other words, it possesses in large degree the power of curing itself. So, when treated (and sometimes in spite of treatment) it recovers, and hence the method used seems to cure. When, however, the powers of resistance and of repair are overwhelmed, as comes sooner or later with all of us, nothing can prevent dissolution, and any and all attempts at cure, used on this occasion, must suffer in repute. A few such failures sealed the doom of remedies whose names have become legion.

Even had there been but one cause of sickness, many means of healing would have been tried, but as we now realize, there are many causes, most of them born of our own personal or communal ignorance or perversity and capable of removal or prevention.

During the long ages when the various causes of disease and the real nature of their cure were a mystery, the long experimentation with means and methods has led to the final sifting out of a few (a very few) physical or chemical agencies which, in certain instances, really are a help. The latest medicine man, looking over the list, is able to select such of these ways and means as have proven of benefit and apply them when and where they may possibly be of service to the body in its struggle back to health.

From the bold and ignorant person, who, because a few patients happen to get well during the administration of one means of cure, applies that method of treatment indiscriminately to all who hopefully seek his aid and pay his price, to the physician who, through long and patient study, learns what is now known of the causes of sickness and who conscientiously and cautiously commands the few resources which can be selected from the age-long therapeutic rubbish heap, from word of hope and hand of message, from quinine and morphine to insulin or antitoxin or the use of the surgeon's knife, the gap is as great as from the stone age to the present.

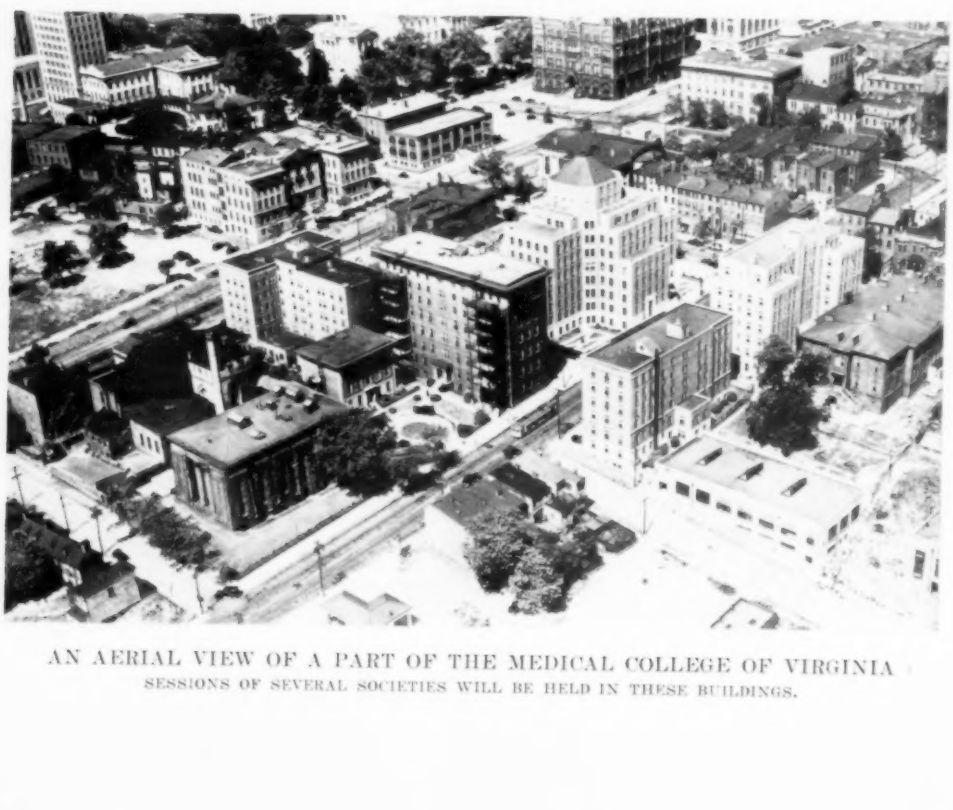
We have progressed mightily in the knowledge of the causes and of the true nature of the cure of disease, but the most important lesson to be learned from the experience is the old one—that an ounce of prevention is worth more than a pound of treatment and that we are wise when we learn the laws of health, personal and communal, and try to obey them.

Instead of depending on cures for the results of bodily sins, we may well follow for the rest of our days the suggestion of the wisest of mankind and "despise no new Accident in our Body," for "there is wisdome in this, beyond the Rules of Physicke: A Man's own Observation, what he find Good of, and what he finds Hurt of, is the best Physicke to preserve Health."

When we are lost in the maze of human experience and are unable to decide what is hurtful or helpful we do well to follow Francis Bacon's further advice and "ask Opinion" of the new and better medicine man who is acquainted with the modicum of good in the many systems of healing that have come and gone, who is wedded to no one cure (as he sees no one cause) for human ills and who is as interested in helping us to work out our bodily salvation and to lead a healthy life (in so far as our heredity and past shortcomings will permit) as he is in helping us out of scrapes due to our carelessness or ignorance.

AN AERIAL VIEW OF RICHMOND'S CIVIC CENTER

THE REGISTRATION, GENERAL SESSIONS AND THE SCIENCE EXHIBITION WILL BE IN THE MOSQUE, NEAR THE CENTER OF THE PICTURE.



AN AERIAL VIEW OF A PART OF THE MEDICAL COLLEGE OF VIRGINIA

SESSIONS OF SEVERAL SOCIETIES WILL BE HELD IN THESE BUILDINGS.

THE PROGRESS OF SCIENCE

THE VIRGINIA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

FROM December 27 to 31, inclusive, the American Association for the Advancement of Science will hold in Richmond its first meeting in Virginia. A year ago the association held its winter meeting in Indianapolis, Indiana; its summer meeting, last June, was held in Ottawa, the capital of Canada; and next summer the association will meet in Milwaukee, Wisconsin. Thus the meetings of the association are held in important cities from Minneapolis to New Orleans, from Boston to Los Angeles.

There are two important reasons for holding the meetings of the association in various parts of the United States and Canada. The first is to carry the inspiration of great gatherings of scientists to all parts of these countries. The second is to enable the scientists of one section after another to meet with their fellow scientists without great expense in time and money for travel.

It is necessary to attend a meeting of the association in order to see science on the march and to feel the warm glow of its spirit. Immediately after next Christmas trains from the Southeast and the South as far west as Texas will be crowded with scientists bound for Richmond; and trains from snowy New England and Canada and from the frozen Middle West will be carrying other scientists to milder Virginia. Some of them will be specialists in the physical sciences—mathematics, physics, chemistry, geology—and the fields of others will be the biological sciences—zoology, botany, medicine, agriculture and all their various divisions and branches. Still others on these Richmond-bound trains will be interested in man: the anthropologists will be interested in him as the product physically, mentally and culturally of a long evolution; the historians and philologists will be interested in the story of his achievements as preserved in his written records and his speech; and the psychologists and educationists will be interested primarily in the nature and cultivation of those marvelous faculties of his which most distinguished him from the remainder of living organisms. The interests of the scientists who will attend the meeting of the association in Richmond in December will be as broad and varied as science. Not only will the fifteen sections of the association hold scientific sessions on nearly every aspect of science, but approximately fifty affiliated special scientific societies will also meet in Richmond.

As the scientists approach Richmond they will not be listening to orders from bosses as to what they should think and say; they will not be anxiously considering the effects their words may have upon special groups; they will not be jockeying for position and preferment. Their rivalries will be in making discoveries and placing them at the service of science and society. They will be happiest when they can give most to their fellow men. In their actions they will illustrate attitudes that are greatly needed for the progress of civilization.

Richmond is a lovely city just where the softer life of the southland rubs elbows with the greater drive and efficiency of the north. It is rich in historical associations. Such names as John Marshall and Lee and Poe give it distinction. The afterglow of a rapidly vanishing aristocratic age still hovers over it. Almost at its door restored Williamsburg brings down the romantic past to the more practical present. The citizens of Richmond are noted for their friendliness and hospitality, and they will make up in warm welcome and attention to the comfort of visitors what

THE EGYPTIAN BUILDING OF THE MEDICAL COLLEGE OF VIRGINIA
THIS BUILDING, BUILT IN 1845, IS ONE OF THE OUTSTANDING EXAMPLES OF EGYPTIAN ARCHITECTURE IN AMERICA.

their city lacks in the facilities of larger centers of population. The visiting scientists will retain memories not only of their inspiring meetings but also of a comfortable, leisurely way of living that still lingers here and there in the Southland. And, reciprocally, Virginia and all its neighbor states will throb with the strong pulse of science that is working revolutions in the life of those areas as well as in that of the remainder of our country. If this should not happen, the Virginia meeting will not fulfil the purpose of the association in holding it in Richmond.

Not all the sessions of the meeting will be devoted to technical papers. The presidential address by Dr. George D. Birkhoff, of Harvard University, will be on the subject "Intuition, Reason, and Faith in Science." Sir Richard Gregory, the distinguished editor of *Nature*, will deliver an address at a general session on the interrelations between science and society. For sixteen years the Society of the Sigma Xi, a great organization of "companions in zealous research," has provided a program for the second evening of the annual meetings of the association. This year Dr. W. F. Durand will be the speaker on "Modern Trends in Aviation." For three years the United Chapters of the Phi Beta Kappa have sponsored addresses by eminent scholars. The fourth lecture in this series will be delivered by Frank Pierrepont Graves on "Is Education a Science?" In addition to these regular features of the programs, there will be numerous addresses on many fields of science that will be of interest to the general public. Perhaps none of greater

importance will be presented than those in the symposium on "Mental Health." The medical profession and society are only now realizing clearly that our minds are subject to about as many disorders and quirks, most of them not serious, as are our bodies, and that they deserve at least equal competent attention. In this symposium organized by the Section on the Medical Sciences the association is making a contribution to the welfare of society in a new field. It is but one of many problems challenging the association.

F. R. MOULTON

SIR RICHARD GREGORY

AMERICAN culture and learning have been enriched through visits to this country, from time to time, of eminent English men of science. In surprising number, both the men of England who are foremost in scientific research and those who have thought deeply about the ultimate values of science possess the power of lucid exposition. Not a few English scientists who have important discoveries to their credit and others who are at home in philosophical discussion talk and write about their work, if occasion calls for it, in a delightfully simple and graphic way. In consequence, such men command large and attentive audiences among Americans whenever a lecture by one of them is announced.

In December next, upon invitation of the Carnegie Institution of Washington, a member of this distinguished group, Sir Richard Gregory, is coming to America to deliver the fifth of the Elihu Root lectures—a series established by the institution in honor of Mr. Root, a trustee from the beginning and chairman of its board during the last twenty-four years of his life.

Sir Richard is widely known among American scientists through his editorship of *Nature*, an English journal, with a large American circulation, which has become an international clearing house for preliminary announcement of scientific researches. For forty-five years he has served this journal, first, as assistant editor and, since 1919, as editor. During the period he has contributed to the journal literally thousands of columns of vigorous editorial comment and observation.

Richard Arman Gregory was born in Bristol in 1864. His father was a shoemaker by trade but a poet by nature and the author of several volumes of beautiful verse. His grandfather was for sixty years a lay preacher of the Wesleyan Church at Bideford, Devon, where a tablet is erected to his memory. Sir Richard Gregory said on one occasion: "My grandfather preached the Gospel of Christ; my father preached the gospel of socialism; and I preach the gospel of science; but the ethical principles of all three are the pursuit of truth and righteousness for the improvement of man and society."

After leaving school at twelve years of age, Sir Richard became in succession a newspaper boy, page boy, machine boy in a printing office and apprentice to the boot and shoe trade. Through his studies before and after factory hours, he came to the notice of the head master of Clifton College, on the outskirts of Bristol, and was given by him a minor post in the physical laboratory of the college.

After leaving the college, he became science instructor at H. M. Dockyard School, Portsmouth, but returned two years later to become research assistant to the great astronomer, Sir Norman Lockyer, who in 1868 discovered in the sun the then unknown gas, named by him helium, which was not identified on the earth until twenty-six years later. In 1893 Sir Richard became associated with Sir Norman as assistant editor of *Nature*, succeeding him as editor in 1919.

Sir Richard Gregory and Mr. H. G. Wells were fellow students at the Royal College of Science, London, and their friendship has remained close and un-

SIR RICHARD GREGORY

broken. They had won studentships at the college in open competition and were to be trained there as science teachers. Mr. Wells has described the aims and hopes and struggles of himself and other students at the college in several of his works, such, for example, as "Love and Mr. Lewisham," and particularly in his "Experiment in Autobiography." Even in those days Mr. Wells showed the distinctive literary powers which have made him preeminent among modern writers, and became the first editor of the *Science School Journal*, with Sir Richard Gregory as one of the contributors.

In the same year, 1895, that Mr. Wells entered the field of imaginative literature with "The Time Machine," the main idea of which he had used in a story in the college magazine while a student, he collaborated with Sir Richard in a small volume entitled, "Honours Physiography," for which each of the authors received the modest sum of fifty dollars.

Sir Richard's early contacts with social reformers and with the stern reali-

ties of life and labor made him familiar with the human aspects of applied science as affecting industry. This probably accounts for the attention given in *Nature* during his editorship to the social relationships of science. He holds that as science is responsible for the industrial developments and economic changes which have caused violent disturbances in the social structure and provided also the means by which civilization may commit suicide, it has a duty to guide the human race to the wise use of the powers it has created.

In line with this conception of the place and purpose of science, Sir Richard declares that the day when men of science were expected to keep within the bounds of their laboratories and any attempt to enter social fields was resented as an intrusion is past. "Fifty years ago," he says, "science had to establish its rights to the pursuit of truth in matters affecting traditional belief, but to-day it is the state and not the church which would suppress intellectual freedom."

Because of his condemnation of actions which destroy this essential condition of progressive knowledge and of the persecution of scientific workers for racial reasons or because they are unwilling to be fettered by political chains, several months ago the minister of education in Germany issued an order that *Nature* should not be taken officially in the universities and public libraries of that country.

In the forthcoming institution lecture, Sir Richard will discuss "Cultural Contacts of Science." In this address he will deal chiefly with the influence that science exerts upon cultural values rather than with the services rendered to communities by the utilitarian uses to which scientific knowledge is put. Carnegie Institution will publish the lecture, so that all who wish a copy may obtain it.

After filling his institution engagement, during the short time Sir Richard is able to be away from England, he will deliver a few lectures in this country.

FRANK F. BUNKER
THE CARNEGIE INSTITUTION
OF WASHINGTON

THE NEW ENGLAND HURRICANE OF SEPTEMBER 21

THE tremendous rise of water or "storm wave" that accompanied the hurricane was probably totally unexpected by most residents of the southern New England coast. It was this inundation, rather than the wind, which really caused the great loss of life and enormous damage to property. However, the storm wave has long been a well-recognized feature of hurricanes. Tannehill, in a recent book on hurricanes,[1] devotes an entire chapter to the phenomenon. He states that "more than three fourths of all the loss of human lives in tropical cyclones has been due to inundations. The rise of the sea over low coastal areas not subject to overflow by ordinary tides is sometimes sudden and overwhelming and in some situations there is no escape."

How applicable the above quotation is to this particular storm! But why was the region of severe inundation confined to a stretch of coast between Martha's Vineyard and the central part of Long Island? As Tannehill further states: "The true storm wave is not developed unless the slope of the ocean bed and the contour of the coast line are favorable. Like the gravitational tide, it reaches its greatest height in certain situations. If there is a bay to the right of the point where the cyclone moves inland, the waters are driven into the bay. With a gently sloping bed, the water is piled up by resistance and becomes a great wave or series of waves which moves forward and to the left, the principal

[1] I. R. Tannehill, "Hurricanes." Princeton University Press, Princeton, N. J., 1938.

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THE SEA IN ACTION AT WOODS HOLE

UPPER: SURF BREAKING OVER THE TOP OF THE SEA WALL. LOWER: WRECKAGE TOSSING IN THE WAVES. THE BUILDING IN BACKGROUND AT THE UPPER LEFT IS THE WOODS HOLE RESIDENCE HOUSE OF THE U. S. BUREAU OF FISHERIES STATION.

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MAIN STREET OF WOODS HOLE LOOKING EAST NEAR HEIGHT OF STORM

SHOWING THE CLUBHOUSE OF THE MARINE BIOLOGICAL LABORATORY AT HIGH WATER FROM BENEATH WHICH TONS OF EARTH WERE WASHED. IN THE MAIN BUILDING, NOT SHOWN, ACROSS THE STREET TO THE WEST, THE WATER ROSE TO A HEIGHT OF FOUR FEET IN THE GROUND FLOOR, CAUSING AN ESTIMATED DAMAGE TO APPARATUS ALONE OF ABOUT $20,000.

inundation usually taking place on the left bay shore. Great storm waves which have taken an enormous toll of human lives have, so far as records are available, occurred in nearly every case in a situation of this kind."

The path of the storm, as Dr. Gardner Emmons notes in commenting on the work of Tannehill, was to the west, that is to the *left*, of Buzzards Bay and Vineyard Sound. In addition, as is well known to oceanographers, the ocean bed to the south has a comparatively gentle slope. Thus the necessary conditions for the development of a storm wave are fulfilled. As Tannehill points out, the coincidence of the arrival of the storm wave with the time of the maximum height of the gravitational tide produces unprecedented high water.

Although present residents of the region have no recollection of any similar catastrophe, Mr. Trayser, in a recent issue of the *Falmouth Enterprise*, records three previous occasions when hurricanes created tidal waves in Buzzards Bay: namely, on August 14 or 15, 1635; September 23, 1815; and in 1869. In commenting on the subject of earlier hurricanes in the region, Dr. Alfred C. Redfield, of Harvard University, in a letter to one of the editors, writes: "You may be interested in information that I draw from my family archives for an account of a similar storm which crossed New England in 1821 and which had a profound, and fortunately constructive, effect on the advancement of knowledge about tropical hurricanes and on meteorology in general.

"My grandfather records, in his 'Recollections,' that on the evening of September 3, 1821, while his stepmother was lying on her deathbed, a gale, short in duration but terrific in violence, passed over Connecticut. For many years thereafter it was spoken of as the 'great September gale.' About a month after this, his father, William C. Redfield, visited Stockbridge to carry to his wife's parents

some of her belongings and to give the sad history of their daughter's last illness. The journey of seventy miles between Cromwell, Connecticut, and Stockbridge was made by wagon and occupied two days. As he drove along, he observed that at Middletown and Cromwell the wind had been from the southeast and the trees lay prostrate with their heads northwest. On reaching Berkshire he was surprised to see that they lay in the opposite direction, and on conversing with the residents of that region, he was astonished to learn that the wind, which at 9 P.M. had been from the southeast at Cromwell, had been in Stockbridge from the northwest at precisely the same hour. These facts at first seemed to him irreconcilable. It did not appear to him possible that two winds of such violence should be blowing directly against each other at the distance of only seventy miles. The only explanation of this paradoxical phenomenon was one which he was then led to accept hypothetically, but which he afterwards confirmed by years of observation and the collection of innumerable facts and which established the circular movement of the wind in great storms. The *American Journal of Science and Arts* of April, 1831, published the detailed record of the course of the great September gale of 1821, based on reports obtained from at least forty places, including ten ships at sea. The earliest trace of the hurricane was from off Turk's Head in the West Indies. The storm crossed over the continental coast south of Cape Hatteras and veered to the northeast, following the coastline closely, its center apparently passing across the mouth of Delaware Bay and hitting the New England coast in the neighborhood of Bridgeport. It passed across the Connecticut Valley and was last observed in northeastern Massachusetts. In New York, at the time of low water, the wharves were overflowed, the water having risen 13 feet in one hour. At Boston the gale commenced at 10 P.M. but does not appear to have been severe. At the time the storm was raging with its greatest fury in New York, the citizens of Boston were witnessing the ascent of a balloon, and the aeronaut met with little or no wind.

"Similar records obtained following two severe northeast storms, which were felt in New York City in 1830, showed them to have a similar course and character, though they followed the more usual route to the south of New England's coast, and led to the first published account of the cyclonic nature of such hurricanes and the plotting of their courses and rates of progression. These studies were continued and amplified by observations of Reid at Bermuda and Piddington and Thom in the Indian Ocean and not only led to the establishment of definite rules for handling vessels on the approach of a hurricane, rules which still appear on the pilot charts, but also laid the basis for the understanding of the cyclonic disturbances which characterize the weather in temperate latitudes and for the synoptic method for analyzing the movements of air masses."

THE LUNAR ECLIPSE OF NOVEMBER 7

THE sun had not yet set and the moon was in the umbra of the earth's shadow when the moon rose at Washington on the afternoon of November 7, at 4:56 P.M., Eastern Standard Time. According to the Ephemeris, the moon was scheduled to begin to emerge from the umbra at 6:07½, to leave the umbra (complete shadow) at 7:12, and to leave the penumbra (partial shadow) at 8:14 P.M. Sunset was at 5:02, and the end of evening twilight at 6:23.

The Naval Observatory's 40-inch reflecting telescope, with a focal length of

THE MOON EMERGING FROM THE SHADOW OF THE EARTH
(LEFT TO RIGHT) AT 6: 14 P.M., 6: 45 P.M., 7: 02 P.M., 7: 16 P.M., E.S.T.

about 23 feet and operated with a relative aperture of 1 : 10, was focused on a star and made ready to photograph the eclipse.

The first glimpse of the totally eclipsed moon, shining dimly in the east from the illumination of a rosy ring of terrestrial sunsets and of the pearly light of the solar corona, was obtained about 5 : 26. With the fading of twilight it became more and more visible, and more colorful—like a slightly tarnished, relatively new penny.

The first of six exposures using the new Kodachrome cut film was made at 6:06, just before the instant of the beginning of the moon's emergence from the umbra. A number of exposures for black-and-white negatives were made on Agfa Isopan films and on Kodak Panatomic plates. The last exposure was made at 7 : 16, through a break in the clouds. Later in the night, the bright silvery moon rode high in the sky, causing one to marvel at the great range through which its illumination had changed within a few short hours.

A sequence of photographs showing

THE PLANET URANUS NEAR THE ECLIPSED MOON

AS SEEN FROM WASHINGTON, D. C., AT 6: 32 P.M., E.S.T., APPEARING AS A WHITE DOT IN THE LOWER RIGHT-HAND CORNER. THE PLATE WAS EXPOSED 15 SECONDS.

the emergence of the moon from the dark shadow of the earth was prepared from the negatives which had been exposed, for durations of the order of ½ second, at 6:14, 6:46, 7:02 and 7:16 P.M., Eastern Standard Time. The pictures show vividly that the earth is round. The earth's shadow appears as part of a circle of greater radius than the radius of the moon and differs in shape from the apparently elliptical terminator of the crescent moon that we usually see. The lunar craters show no shadows. All the expected characteristics of the shadow theory of a lunar eclipse are to be found.

Two photographs of longer (15 and 30 seconds) duration of exposure, obtained to show the illumination of the portions of the moon within the earth's umbra, show, as an unexpected feature, the major planet Uranus, on the limits of visibility to the unaided eye, appearing close to the moon as seen from Washington. While the eclipse was in progress, Uranus was seen and recognized by one of the staff who was watching the eclipse with the 26-inch refracting telescope. Uranus is the planet which was discovered and recognized to be a planet by William Herschel, in 1781, after it had been mistaken for a fixed star about 20 times during the preceding hundred years; it is the first planet which was added to the known solar system after the invention of telescopes.

J. F. HELLWEG
U. S. NAVAL OBSERVATORY

ARCTIC POTATOES

It is northward just now that the course of empire is taking its way—but an "empire," like an army, must crawl on its belly.

Perhaps the most notable example of this northward progress is the industrialization of the frigid Kola Peninsula above the Arctic Circle by the Soviet Government, which seeks to take advantage of the rich mineral resources. Cities have sprung up, but cities need truck gardens and in that region the temperature sometimes sinks to around 25° F., the killing frost stage, in early August.

So the government has set up an Arctic plant breeding station there, and from this station have just come reports of the first success in breeding a potato highly resistant to freezing. At elevations as high as 5,000 feet in the Andes the Russian plant explorer, S. V. Juzepezuk, found a wild potato which did not seem to be injured by anything less than a killing frost during its blossoming season. With dark green leaves more than twice as thick as ordinary potato leaves growing in a rosette which almost hugs the ground, this vegetable withstood cold of 18° F. without apparent injury in North Russia.

It bears tubers, however, only under the twelve-hour day of the equatorial regions and only barren roots under the twenty-four hour day of North Russia's summer. It produced, however, an abundance of seed balls, according to the account just published in the *Comptes Rendus* of the Soviet Academy of Sciences by L. A. Dremliug, one of the staff of the polar station.

Six years ago, after many futile attempts, the first successful cross was made between this wild potato and a variety of the potato of agriculture, *Solanum tuberosum*. The cross was less frost-resistant than the wild plant of the high Andes, but still it withstood temperatures of 27° F. without injury.

The hybrid remained, however, a short-day potato. Transferred from the Soviet Potato Institute garden at Moscow to the Kola Peninsula it produced seed balls but not tubers. The next step was to make a cross between this hybrid and another variety of *Solanum tuberosum*, thus producing a triple hybrid with two thirds of its genes those of the domestic vegetable.

This was accomplished only with great difficulty. The experiment finally succeeded, according to Dr. Dremliug's account, only when the cross was made at the end of August when the temperature was steadily close to the freezing point. Only a very few seeds were obtained, only seven of these produced plants when planted the next year, and only two of these plants yielded any tubers. The tubers themselves were about the size of hickory nuts.

When these were used as seed potatoes the next year, however, the results were quite different. The plants which sprang from the cuttings resembled the Andean ancestor in their dark-green, thick leaves growing in a ground-hugging rosette. They flowered in profusion and bore seed balls. The tuber production under long-day conditions remained inconsequential, but when the plants were grown in cold frames in which the light could be regulated they produced good yields. They withstood temperatures of 25° F.

The problem of obtaining a good yield in the open field still remains to be solved, but it has not been advanced to the next stage—the back-crossing with other varieties of the domestic potato. The Soviet botanists have high hopes that one or another of the crosses will yield a long-day potato which will retain the frost-resistant character of the wild potato of the Andes.

They have apparently, Dremliug says, crossed the first great hurdle of producing fertile crosses. The flowers must be pollinated at close to freezing temperatures. The cold-resistant quality of the triple hybrid is apparently associated in some way, he says, with the fact that it has double the number of chromosomes in all its tissue cells as does the ordinary potato. About the same effects as are achieved with colchicine by American experimenters, he believes, are brought about by the hybridization in frigid temperatures.

Successful breeding of a frost-resistant potato might well be the turning point in the history of the Far North, both in the Old and New Worlds. The eyes of Canada as well as those of Russia are turned northward, and the great Arctic empire of Alaska remains largely virgin territory. Canadian pioneers and missionaries have grown potatoes successfully "north of sixty," it was reported at the American Association for the Advancement of Science meetings at Ottawa last summer. But as yet the crop is undependable and an early, severe frost will ruin it.

THOMAS HENRY

THE STUDENT OR THE FISH

—From Punch

PROFESSOR OF ZOOLOGY: "I DON'T TRY TO REMEMBER ANY STUDENTS' NAMES; EVERY TIME I REMEMBER THE NAME OF A STUDENT I FORGET THE NAME OF A FISH."

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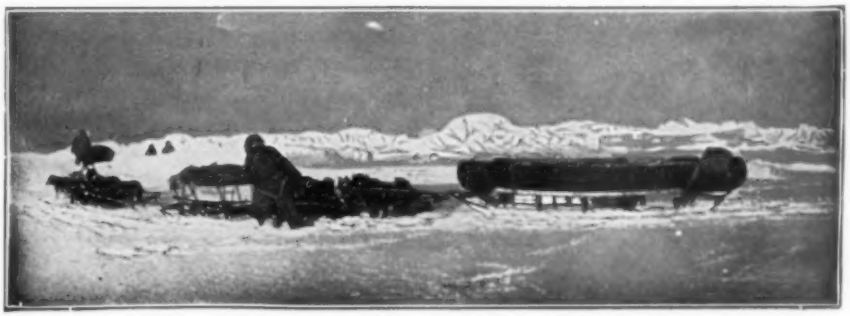

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